CLARK FORK BASIN PERIPHYTON MONITORING:

AN ASSESSMENT OF BIOLOGICAL INTEGRITY AND IMPAIRMENT BASED ON ALGAE ASSOCIATIONS DURING AUGUST OF 2000

prepared for:

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Department of Environmental Quality
Planning, Prevention and Assistance Division

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SUMMARY

Periphyton (benthic algae) samples were collected from natural substrates at 28 locations on the Clark Fork of the Columbia River and major tributaries during mid-August of 2000 by a contractor for the Montana Department of Environmental Quality (DEQ), Planning, Prevention and Assistance (PPA) Division. This monitoring was conducted for the purpose of assessing water quality, biological integrity and overall impairment of aquatic life as part of the ongoing Clark Fork Basin Project. Similar algae surveys have been conducted annually by the State of Montana since 1986.

Samples were analyzed for relative abundance of non-diatom algal genera, dominant non-diatom phylum, and relative abundance of diatom species. The total percent relative abundance of diatom species in each of three pollution tolerance groups were calculated. Diatom metrics calculated included: diatom species richness, Shannon species diversity, pollution index, siltation index and percent similarity index. An assessment protocol utilizing specific criteria based on diatom metrics was used to determine biological integrity, overall impairment of aquatic life and degree of support of aquatic life beneficial uses at each station monitored during 2000.

During August 2000, monthly mean streamflows throughout the Clark Fork Basin were well below average for the twelve year period of record for periphyton monitoring due to extended drought.

Blacktail Creek, the principal headwater tributary to Silver Bow Creek, had good biological integrity with minor impairment, and fully supported beneficial aquatic life uses. Diverse non-diatom and diatom algae indicated relatively unimpaired water quality during August 2000.

Silver Bow Creek (SBC) above the Butte wastewater treatment plant (WWTP) had good biological integrity with minor impairment of aquatic life, while SBC downstream of the WWTP and Superfund Lower Area One (the former Colorado Tailings site) and SBC above the Warm Springs Ponds at Opportunity both exhibited severe overall impairment of aquatic life and poor biological integrity during August 2000. Elevated levels of sediment, heavy metals, biogenic wastes and nutrients continued to seriously impact this reach. Significant improvement above the Butte WWTP was apparent during 2000 as a result of recent Superfund remediation efforts. Moderate impairment of aquatic life with only partial support of beneficial uses was indicated at the Silver Bow Creek downstream of the Warm Springs Ponds in 2000, due to an elevated siltation metric. Nutrient enrichment was also indicated below the ponds.

The station on the Mill-Willow Bypass was re-established in 1999 on the reconstructed channel near Warm Springs. Biological integrity was excellent and aquatic life unimpaired in August 2000, indicating very good water quality.

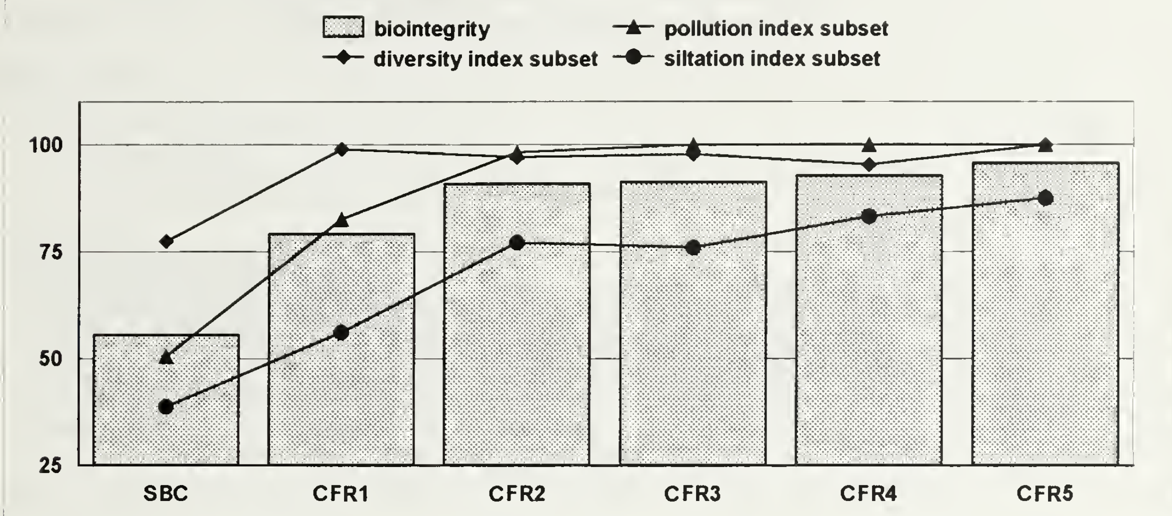
Warm Springs Creek had only fair biological integrity with moderate impairment of aquatic life indicated during August 2000, based on an elevated siltation metric. However, other diatom and non-diatom metrics suggested a largely unimpaired biota in Warm Springs Creek, and good water quality in this important tributary to the upper Clark Fork.

Biological integrity in the Clark Fork between Warm Springs Creek and the Little Blackfoot River was only fair at the upper stations, but improved to good in the lower section during August 2000. Siltation was indicated as the cause for moderate impairment of aquatic life in this reach, with nutrients and physical stress also contributing to minor impairment near Deer Lodge.

Biological integrity in the Clark Fork between the Little Blackfoot River and Rock Creek was generally good throughout the reach, with full support of beneficial uses and only minor impairment of aquatic life during August 2000 due to sediment impacts. Minor impairment of aquatic life was indicated in the Little Blackfoot River, and moderate impairment indicated in Flint Creek and Rock Creek during August 2000, again due only to sediment impacts. The Blackfoot River was unimpaired, with excellent biological integrity during 2000. The Clark Fork stations at Turah and above Missoula were rated as having only fair biological integrity with moderate aquatic life impairment due to siltation, although other metrics indicated the biota was largely unimpaired.

In the Clark Fork downstream of Missoula, moderate impairment was indicated from below the Missoula wastewater treatment plant to below the Bitterroot River due to sediment, although other metrics rated this reach unimpaired. The Bitterroot River had excellent biological integrity with full support of beneficial uses in August 2000. The Clark Fork station at Huson could not be accessed in 2000 due to extreme fire danger. Lower Clark Fork stations, above and below the Flathead River, fully supported beneficial aquatic life uses, with little or no impairment indicated in August 2000.

Figure S1. Longitudinal trends - Mean biointegrity (%) of stream reaches in the Clark Fork Basin during August 1989 - 2000. Values are percent of total possible score, as the mean of impairment ratings (from 1 to 4) assigned to each data set over 12 years.



Stream reaches: SBC = Silver Bow Creek; CFR1 = Clark Fork from Warm Springs Creek to Little Blackfoot River; CFR2 = Clark Fork from Little Blackfoot River to Turah; CFR3 = Clark Fork from Blackfoot River to Bitterroot River; CFR4 = Clark Fork from Bitterroot River to Alberton; CFR5 = Clark Fork from Alberton to Flathead River

Longitudinal trends in mean biological integrity for stream reaches in the Clark Fork Basin over the twelve years 1989-2000 are plotted in Figure S1. Biointegrity, and the diversity, pollution and siltation index subset values, are the means of impairment rating scores assigned under bioassessment Protocol I (Bahls 1993), which range from 1 to 4, with 1 = severe impairment, 4 = no impairment. Values are expressed as a percentage of the maximum possible mean score of 4. Biointegrity is the mean of all three subset values. Biointegrity was poorest over the last twelve years in the Silver Bow Creek and upper Clark Fork reaches, and improved with distance downstream. Low siltation index values strongly influenced biointegrity by depressing the mean. Diversity and pollution index subsets generally approached 100 percent at the middle and lower Clark Fork reaches.

Temporal trends are assessed using mean values for impairment rating scores in each subset, and as a total of all subsets, again expressed as a percentage the maximum possible score of 4, determined sequentially over twelve years for all Silver Bow Creek stations (Figure S2) and for all Clark Fork mainstem stations (Figure S3). Figure S2 shows relatively constant biointegrity at Silver Bow Creek stations, with a definite improving trend indicated over the last five or six years. The siltation index subset for Silver Bow Creek suggests steady improvement through the period of record. The Clark Fork mainstem stations (Figure S3) had very constant mean biointegrity through the sequence, with a decline and subsequent improvement in the siltation index, and a less-pronounced opposite trend for the pollution index and diversity index subsets over the period of record.

Figure S2. Temporal trends - Mean sequential biointegrity (%) in Silver Bow Creek during 12 years of monitoring (1989-2000).

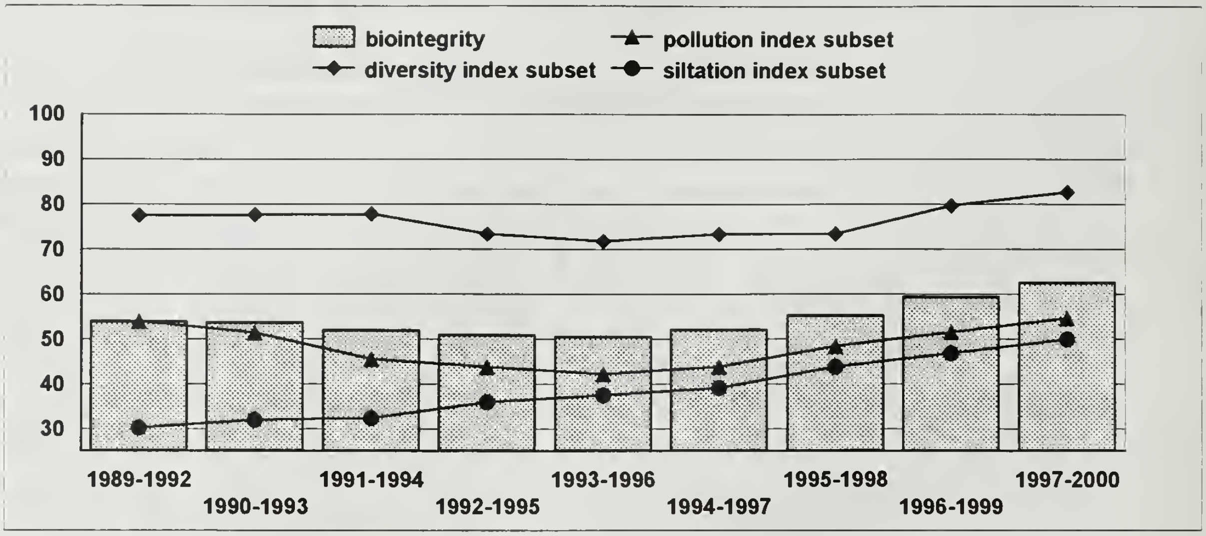
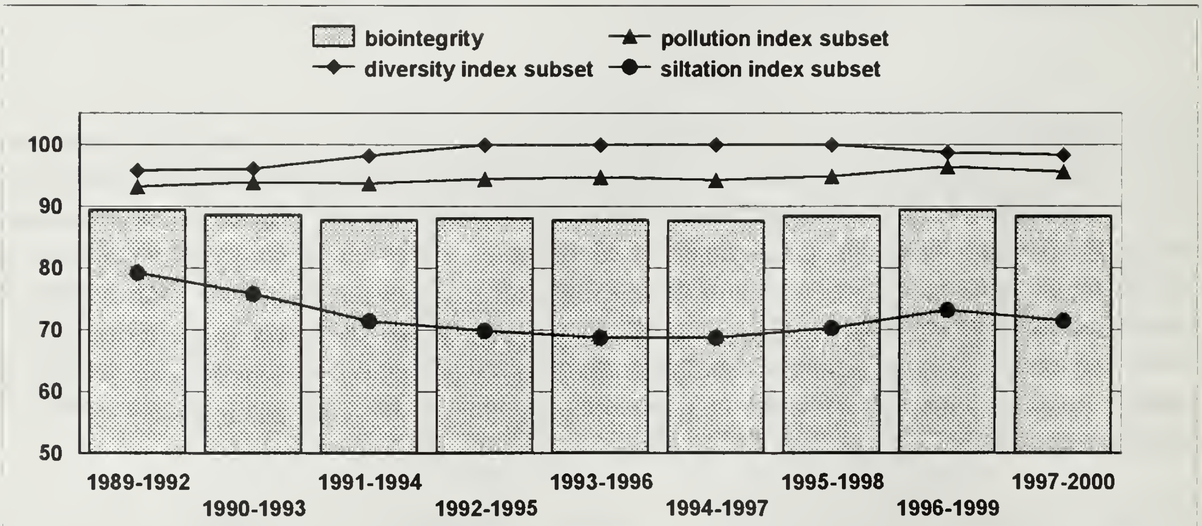


Figure S3. Temporal trends - Mean sequential biointegrity (%) in the Clark Fork during 12 years of monitoring (1989-2000).



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INTRODUCTION

In August of 2000, the Montana Department of Environmental Quality (DEQ) - Planning, Prevention and Assistance (PPA) Division contracted for benthic algae surveys to be conducted at 28 sites on the Clark Fork of the Columbia River and selected tributaries as part of the ongoing Clark Fork Basin Monitoring Project. Similar surveys have been conducted annually by DEQ (and its predecessor DHES) since 1986 (Bahls 1987 and 1989; Weber 1991, 1993, 1995, 1996, 1997, 1998, 1999 and 2000).

This report presents the results of analyses performed on periphyton samples collected during the 2000 monitoring. Various metrics are employed to assess water quality and biological integrity at the stream sites surveyed. Longitudinal and temporal trends in water quality and biological integrity are also evaluated. Bahls (1993) states: "The concept of biological integrity is the basis for biological assessment and the setting of ecological goals for water quality." As defined by Karr and Dudley (1981): "Biological integrity is the ability of an aquatic ecosystem to support and maintain a ... community of organisms having species composition, diversity, and functional organization comparable to that of the natural habitats within a region." **This definition makes the explicit assumption that natural, undisturbed systems are better than those affected by human activities.**

Periphyton is the assemblage of small, often microscopic organisms (microinvertebrates, bacteria, fungi, and benthic algae) that occur in aquatic habitats, and live attached to or in close association with the surfaces of submerged substrates. Benthic algae typically dominate the periphyton community in freshwater streams. These algae can be divided into two major groups: diatom algae, which possess a rigid siliceous cell wall, or "frustule," and the non-diatom or soft-bodied algae, which lack a siliceous cell wall. The taxonomy of both groups has been well established. Because the shape and ornamentation of diatom frustules are unique to individual taxa, diatoms are readily identifiable to species. It is generally impractical to identify non-diatom algae below the genus level.

Algae, and particularly the diatoms, are useful as biomonitors of water quality because they occur in very large numbers, are highly sensitive to physical and chemical factors, and have known environmental requirements and pollution tolerances unique to individual species (Bahls 1989). Plafkin et al. (1989) lists several other advantages of using algae for bioassessment:

- Algae generally have rapid reproduction rates and very short life cycles, making them valuable indicators of short-term impacts. (Perennial and fossil algae, including expired but recognizable algae within the periphyton matrix, reflect longer term impacts).

- As primary producers, algae are most directly affected by physical and chemical factors.

- Sampling is easy, inexpensive, requires few people, and creates minimal impact to resident biota.

- Relatively standard methods exist for evaluation of functional and non-taxonomic structural characteristics (e.g., biomass and chlorophyll) of algal communities.

- Algal communities are sensitive to some pollutants which may not visibly affect other aquatic communities, or may only affect other communities at higher concentrations (e.g., herbicides and inorganic nutrients).

Generally, periphyton collected from a particular stream location will reflect the environmental conditions that existed there for up to several weeks prior to sample collection. However, many factors in addition to water quality affect the types and amount of algae present at a given time. These include but are not necessarily limited to: streamflow extremes, substrate scour, variable recolonization rates, normal seasonal succession, and sloughing of algal biomass late in the season. Any bias introduced by factors not directly related to water quality can be minimized by sampling at the same time each year, well after the spring spate but before major sloughing of algal biomass occurs in late summer and early fall. Monitoring conducted during the month of August appears to satisfy the aforementioned criteria. Additionally, it likely encompasses the period of poorest seasonal water quality and maximum environmental stress on stream biota due to low streamflow, elevated water temperature, and minimum instream dilution of pollutants and wastewater discharges.

METHODS

Periphyton was collected at 27 monitoring stations on the Clark Fork and selected tributaries in 2000 (Table 1 and Figure 1). Included were all but one of the 28 stations monitored in 1999. The Clark Fork at Huson (station 22) was not sampled in 2000. The extremely dry conditions and numerous wildfires in August 2000 prompted the Governor to declare a fire emergency about a week before the scheduled monitoring, shutting down essentially all outdoor activities. A permit was obtained from the Department of Natural Resources and Conservation (DNRC) that allowed for limited work along the river corridor under very tight restrictions. Access to station 22 was blocked by a locked gate at a considerable distance from the river, and alternatives were unavailable due to the fire restrictions.

Sampling was conducted August 14-19, 2000. A single composite periphyton sample was collected from natural substrates at each of the stations by Erich Weber of *Phyco*Logic, according to Procedure 6.2.2 (Periphyton) in the Water Quality Division's Field Procedure Manual (DHES 1989) and section 6.1.1 of Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers (Barbour *et al.* 1999).

Each sample was processed and analyzed by the author in the following manner: A subsample of periphyton from each station was examined under an Olympus BHT compound microscope at 200X and 400X magnifications, and all soft-bodied (non-diatom) algae present were identified to genus. The relative abundance of cells belonging to each genus was estimated using the following system:

- R (Rare): Fewer than one cell per microscope field at 200X, on the average;
- C (Common): At least one, but fewer than five cells per field of view;
- VC (Very Common): Between 5 and 25 cells per field of view;
- A (Abundant): Greater than 25 cells per field of view, but numbers within limits reasonably counted;
- VA (Very Abundant): Number of cells per field too numerous to count.

The abundance of diatom algae (all genera collectively) relative to the non-diatom taxa was estimated for comparative purposes.

Non-diatom genera that ranked common or greater in estimate relative abundance were considered dominant taxa. Each dominant taxon, as well as the diatom component if it met this criterion, was ranked according to its estimated contribution to the total algal biovolume present in the sample. The taxon contributing the greatest biovolume was ranked number 1, the second most number 2, and so on. These rankings were used to calculate the dominant non-diatom phylum (see Non-Diatom Algae Metrics, below).

Following analysis of non-diatom algae, organic matter was chemically oxidized from each sample. A permanent strewn mount of the cleaned diatom frustules was prepared on a glass microscope slide according to "Standard Methods" (APHA et al. 1980). Each permanent mount was thoroughly scanned under a 1000X, 1.25 N.A. oil immersion objective, and all diatom algae encountered identified to species. A proportional count of approximately 800 diatom valves (400 frustules) was performed on each permanent mount, and the percent relative abundance (PRA) of each diatom species was calculated. Diatom species identified during the floristic scan but not tallied during the proportional count were designated as “present” with a letter “p”.

Each diatom species was assigned to one of the three groups originally defined by Lange-Bertalot (1979) based on the species response to organic (biogenic) pollution. Simply stated, **group 1** taxa are most tolerant of pollution, **group 2** taxa less tolerant, and **group 3** most intolerant of (or sensitive to) pollution. Bahls (1993) published expanded autecological criteria for assigning diatom taxa to pollution tolerance (PT) groups, along with an extensive listing of diatom taxa reported from Montana. He also determined default PT group assignments, by genus, for taxa lacking sufficient autecological data. A number of unlisted taxa were assigned to PT groups by the author, based on updated autecological data in references by Krammer and Lange-Bertalot (1986, 1988, 1991a, 1991b) and Lange-Bertalot (1993). Default PT group assignments were used only as a last resort.

Table 1. Periphyton sampling locations for Clark Fork Basin Project, August 2000. Station 22, Clark Fork at Huson, could not be sampled in 2000.

Station Number	Stream and Site name
SF-1	Blacktail Creek (BTC) above Grove Gulch
00	Silver Bow Creek (SBC) above Butte Metro Wastewater Treatment Plant (WWTP)
01	Silver Bow Creek below Lower Area One (former Colorado Tailings site) and Butte Metro WWTP, at Rocker
2.5	Silver Bow Creek at Opportunity
MW2	Mill Creek-Willow Creek Bypass (MWB) near mouth
4.5	Silver Bow Creek below Warm Springs Ponds
06	Warm Springs Creek (WSC) near mouth
07	Clark Fork (CFR) below Warm Springs Creek
08	Clark Fork near Dempsey
8.5	Clark Fork at Sager Lane
09	Clark Fork at Deer Lodge
10	Clark Fork above Little Blackfoot River
10.2	Little Blackfoot River (LBR) near mouth
11	Clark Fork at Gold Creek Bridge
11.5	Flint Creek (FTC) at New Chicago
11.7	Clark Fork at Bearmouth
12	Clark Fork at Bonita
12.5	Rock Creek (RKC) near Clinton
13	Clark Fork at Turah
14	Blackfoot River (BFR) at USGS Station near mouth
15.5	Clark Fork above Missoula
18	Clark Fork at Shuffields (and below Missoula WWTP)
19	Bitterroot River (BRR) near mouth
20	Clark Fork at Harper Bridge
22*	Clark Fork at Huson (and below Stone Container Corporation)*
24	Clark Fork near Superior
25	Clark Fork above Flathead River
27	Clark Fork above Thompson Falls Reservoir

* not sampled in 2000.

Figure 1
Clark Fork Basin Monitoring Project

Non-Diatom Algae Metrics

Metrics applied to soft-bodied or non-diatom algae at each station include: **number of dominant genera**, **dominant phylum** and **indicator taxa**.

The **number of dominant non-diatom genera** is generally inversely proportional to the degree of pollution in western Montana streams. In least-impaired reference streams from mountain ecoregions in Montana, which included mountain valleys and foothills, Bahls (1993) reported from 1 to 10 (mean 5) dominant non-diatom genera. In pristine waters, low numbers of non-diatom genera generally indicate nutrient-poor conditions. Higher numbers of genera in unimpaired streams may indicate naturally higher levels of algal nutrients determined by the local mineralogy.

The **dominant non-diatom phylum** was determined by calculating the cumulative weighted rank of genera within each phylum based on estimated biovolume. Diatoms were not included in this metric. Briefly, in a sample with x number of dominant non-diatom genera, the genus ranking highest in estimated biovolume scored x points, second highest, x-1 points, and so on. The phylum having the greatest total points was considered dominant based on estimated relative biovolume. Green algae (phylum Chlorophyta) generally increase in abundance where the concentration of available nitrogen is sufficiently high relative to available phosphorus. Where nitrogen is in short supply, blue-green algae (phylum Cyanophyta) often dominate due to the ability of many the Cyanophyta to "fix" atmospheric nitrogen. Bahls et al. (1992) found that blue-green algae dominated the non-diatom flora of Northern Rockies reference streams, while green algae were co-dominant with blue-green algae in streams of the Montana Valley and Foothill Prairies ecoregion. The Clark Fork mainstem is considered to be primarily in the Montana Valley and Foothill Prairies ecoregion, as are the main reaches of tributary streams included in this monitoring.

Diatom Metrics

Metrics calculated for diatom associations at each station include **species richness**; the percent relative abundance (PRA) of the **dominant diatom taxon**; **Shannon diversity index**; **pollution index, siltation index, disturbance index** and **similarity index**. Judgement criteria for rating biological integrity, environmental impairment and aquatic use support using these metrics are found in Table 5.

Species richness is a basic indicator of community health and as a rule correlates directly with water quality: as water quality declines, so does the number of species. In general, unpolluted waters in Montana have more than 25 diatom species counted (Bahls 1979). In reference streams from mountain ecoregions in Montana, between 23 and 51 (mean 33) diatom species were counted (Bahls et al. 1992).

The **Shannon diversity index** (Weber 1973) incorporates elements of species richness with equitability, the evenness of distribution of individuals among the species present. High diversity

values occur in diatom communities where no taxa are strongly dominant in numbers, generally the case in healthy, unimpaired streams. In diatom communities under environmental stress, the majority of individuals present belong to a relatively small number of taxa, resulting in lower diversity index values. In general, unpolluted waters in Montana have Shannon diversity values greater than 3.00 (Bahls 1979). Diatom species diversity values of between 2.16 and 4.50 (mean 3.58) were found in 21 least-impaired reference streams from mountain ecoregions (Bahls 1993).

The **pollution index** was proposed by Bahls (1993) as a shorthand method of summarizing the information contained in the three pollution tolerance groups of Lange-Bertalot (1979). The index is derived from the decimal fraction of the total PRA of diatom taxa in each pollution tolerance group, multiplied by the respective group number. The sum of these three products is the pollution index. The index will range from 1.00 (all most tolerant taxa) to 3.00 (all most sensitive taxa). Pollution index values of between 2.45 and 2.94 (mean 2.72) were determined by Bahls (1993) for diatom communities in reference streams from mountain ecoregions.

The **siltation index** is defined as the total percent relative abundance of diatom species belonging to the genera *Navicula*, *Nitzschia* and *Surirella* present in a sample. These genera are comprised largely of highly motile, biraphidean diatoms that are better adapted to existence on unstable, shifting substrates. Values can range from 0 to 100; in mountain reference streams the index ranged from 0.0 to 50.3 (mean 14.5) (Bahls 1993).

The **disturbance index** is simply the percent abundance of the diatom *Achnanthes minutissima*. This cosmopolitan species is an attached form that often pioneers and dominates recently disturbed or scoured sites. While sensitive to organic pollution, *A. minutissima* is quite tolerant of heavy metals and chemical pollutants often associated with mine wastes. The percent abundance of *A. minutissima* has been found to be directly proportional to the time elapsed since the last scouring streamflow or episode of toxic pollution.

The **similarity index,** or percent community similarity (Whittaker 1952) is the sum of the lower of the two percent relative abundance values for all diatom taxa that are in common between two samples. It may be used to gauge the relative amount of impairment or recovery that occurs between adjacent mainstem study sites.

Bioassessment

The two bioassessment protocols (Protocols I and II) utilizing diatom metrics were proposed by Bahls (1993) to assess **biological integrity** and aquatic life impairment in Montana streams. Protocol I compares Shannon diversity index, pollution index, and siltation index values from a study site to criteria developed from least-impaired reference streams located in the same physiographic province, or "ecoregion. Criteria for mountain streams were developed with data from 21 reference streams in the Northern Rockies, Middle Rockies, and the Montana Valley and Foothill Prairies ecoregions (Bahls et al. 1992). Protocol I was applied to Clark Fork Basin diatom data from 1991 through 1998 (Weber 1993, 1995, 1996, 1997, 1998 and 1999). An updated version of this protocol utilizing additional metrics was first applied to the diatom data from 1999, and will again be used with the 2000 data, according to the criteria listed in Table 5. These modified criteria are as of yet unpublished (Dr. Loren Bahls, personal communication). Each of the metrics generated for a study site is given an individual rating and assigned a score based on the criteria in Table 5. The lowest rating or score determines the overall biological integrity, level of impairment and use support rating for the aquatic community at that station. As with the original protocol, the criteria should only be used with data collected during the summer months.

Protocol II, which compares diatom metrics values from a study site to values from a local upstream or sidestream reference site sampled at the same time, was applied to Clark Fork Basin diatom data from 1993 through 1996 (Weber 1995, 1996, 1997 and 1998). A component of Protocol II is the **similarity index** or percent community similarity, which is described under diatom metrics, above. Comparisons of study and reference sites located in different drainages often resulted in low scores due to very dissimilar diatom floras. Because the lowest score established the overall biological integrity and impairment rating (as with Protocol I), ratings were often driven downward by the use of the similarity index in this fashion. It is likely that differences between the diatom floras at Clark Fork mainstem stations and tributary reference streams (such as Rock Creek or the Blackfoot River) is a natural condition, and not related to water quality degradation (Dr. Loren Bahls, personal communication). For this reason Protocol II was not used to assess the 2000 data (or those from 1997-1999). Similarity Index values will be used to assess change between adjacent sites on Silver Bow Creek and the Clark Fork mainstem.

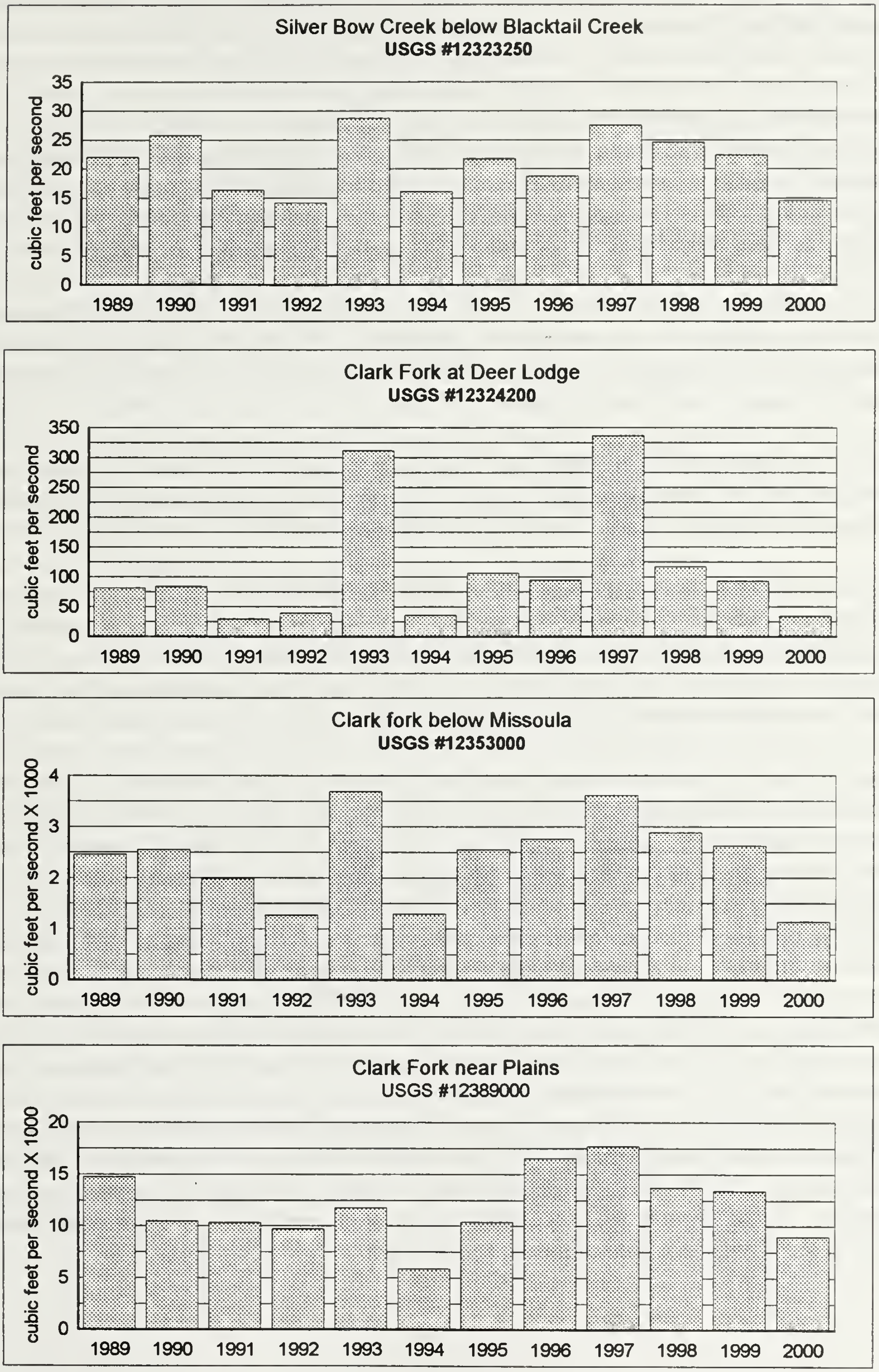
RESULTS AND DISCUSSION

Monthly mean streamflows for August of the twelve-year period 1989-2000 at selected USGS gaging stations in the Clark Fork Basin are presented in Table 2 and Figure 2. Streamflows during August of 2000 were at or near low values recorded for the previous eleven years, and were considerably lower than the near-average monthly mean flows seen in 1999. While the extended drought was having an impact on instream flows in the Clark Fork Basin, none of the streams appeared to be critically low from the standpoint of the biota, and water temperatures generally were below 20 degrees Celsius during the afternoon. Lower flows were again conducive to algal growth and ease of sample collection, and most mainstem Clark Fork reaches had substantial algal standing crops in 2000.

Table 2. August monthly mean streamflows at selected USGS gaging stations in the Clark Fork Basin for the years 1989-2000 (cubic feet per second).

Year	Silver Bow Creek below Blacktail Creek USGS # 12323250	Clark Fork at Deer Lodge USGS # 12324200	Clark Fork below Missoula USGS # 12353000	Clark Fork near Plains USGS # 12389000
1989	22.0	81.7	2464	14750
1990	25.8	84.3	2554	10510
1991	16.4	30.1	1997	10350
1992	14.2	40.1	1280	9738
1993	28.7	312	3696	11770
1994	16.1	36.3	1295	5891
1995	21.8	107	2561	10360
1996	18.7	95.2	2766	16530
1997	27.5	337	3620	17700
1998	24.6	117	2890	13700
1999	22.4	93.4	2625	13420
2000	**14.5**	**34.5**	**1145**	**9010**
Mean	21.1	114.1	2408	11997

Figure 2. August monthly mean streamflows at selected USGS gaging stations in the Clark Fork Basin for the twelve-year period 1989-2000.



Non-Diatom Algae

All genera of non-diatom algae identified at each of the Clark Fork and tributary stations during August 2000 are listed by phylum in Appendix A, along with estimated relative abundance and biovolume contribution rankings. Diatom algae (all genera considered collectively) are also included for comparison. The number of dominant non-diatom genera (those common or greater in estimated relative abundance) and the dominant phylum are also listed in Appendix A. Numbers of dominant non-diatom genera by phylum as green algae, blue-green algae and "other" (yellow-green, brown and red) algae for 2000 are plotted in Figure 3. The top five non-diatom genera at each of the stations sampled during 2000, as determined by estimated biovolume contribution, are listed in Tables 3 and 4. Diatoms were ranked at least seventh in estimated biovolume and are listed for comparison.

In 2000, the number of dominant non-diatom algal genera present at the 27 Clark Fork and tributary stations ranged from 3 to 13 (mean 9.9). **Silver Bow Creek at Opportunity (station 2.5)** and **Clark Fork at Deer Lodge (station 09)** were the only stations with fewer than 5 non-diatom genera present in August 2000 (Table 3; Figure 3).

Green algae (phylum Chlorophyta) were dominant (based on estimated biovolume) at 22 of 27 stations, while blue-green algae (phylum Cyanophyta) were dominant at only three stations. Green and blue-green algae were co-dominants at two stations in 2000 (Appendix A).

Non-diatom algae in **Blacktail Creek above Grove Gulch (station SF-1)** were represented by the filamentous Chrysophyte *Vaucheria* and the filamentous greens *Oedogonium* and *Microspora* (Table 3). These taxa generally prefer cool, clean, well-aerated flowing water that is somewhat soft and moderately rich in algal nutrients. Blue-green algae were entirely absent in 2000 (Appendix A). Diatom algae ranked second in estimated biovolume relative to the non-diatom taxa.

The three Silver Bow Creek stations upstream of the Warm Springs Ponds had from three to eight dominant non-diatom taxa in 2000 (Figure 3). **Silver Bow Creek above the Butte WWTP (station 00)** was dominated by the colonial green alga *Gloeocystis*, the filamentous greens *Cladophora* and *Enteromorpha*, the and the filamentous blue-green *Oscillatoria* (Table 3). All of these taxa, and particularly the green algae, prefer moderately high algal nutrient and alkalinity levels. Reclamation activities along this reach within the last three years, including liming of groundwater and soil fertilization, are likely influences on the algal flora. The non-diatom algae at this station had little in common with those present in Blacktail Creek a short distance upstream. **Silver Bow Creek below Lower Area One** (the former Colorado Tailings) **(station 01)** was dominated by the filamentous Chrysophyte *Vaucheria* and green algae *Stigeoclonium* and *Gloeocystis*, with diatom algae also very important (Table 3). The Butte Metro wastewater discharge accounts for much of the streamflow in Silver Bow Creek at station 01, and strongly influences the water quality with elevated nutrients, dissolved solids and temperature for a considerable distance downstream of the confluence. Additionally, extensive deposits of mill tailings line the Silver Bow Creek floodplain between stations 01 and 2.5. These historic deposits contribute elevated levels of dissolved copper, zinc and other heavy metals, as well as toxic sediments, to this reach.

Silver Bow Creek at Opportunity (station 2.5) had only three dominant non-diatom taxa in 2000 (Figure 3), and was strongly dominated by the highly pollution-tolerant green alga *Scenedesmus* (Table 3). The number of non-diatom algal taxa present at Blacktail Creek and three upper Silver Bow Creek stations in 2000 decreased sharply with distance downstream, with pollution-sensitive forms giving way to pollution-tolerant forms.

Silver Bow Creek below Warm Springs Ponds (station 4.5) had eleven dominant non-diatom taxa present in August 2000 (Figure 3). Both green and blue-green genera contributed significantly to the total algal biovolume at station 4.5 (Table 3). The diverse assemblage was dominated by the green algae *Oedogonium, Cladophora* and *Stigeoclonium*, all filamentous forms, and the blue-greens *Nostoc* and *Phormidium.* Much of the channel was also heavily colonized with rooted macrophytes, giving the impression of a spring creek. It is obvious through comparison with station 2.5 upstream that the water quality in Silver Bow Creek is greatly improved below the Warm Springs Ponds. All indications are that relatively clean, well-aerated, albeit nutrient-rich water was flowing from Warm Springs Pond #2. However, while the pond system effectively removes heavy metals while contributing to the richness (i.e. algal nutrients and bicarbonate) of Silver Bow Creek at station 4.5, it appears that the significant volume of cool, high-quality water from the combined Mill and Willow Creeks is also very important. A large school of very respectable rainbow and brown trout was observed in a pool above the sampling site, apparently unstressed by the 17° C. water temperature at mid-day, and undisturbed by fishermen due to the total recreation ban instituted as a precaution to the extreme fire danger.

Mill Creek-Willow Creek Bypass near mouth (station MW2) was re-established in 1999, seven years after the original study station 5 was eliminated due to Superfund remediation and reconstruction activities. The site monitored in 1999, a Superfund Program monitoring station, could not be accessed in 2000. A comparable site was found closer to the lower end of the Mill-Willow Bypass, adjacent to the parking area at the end of the Dept. of Fish, Wildlife and Parks recreation access road south of Warm Springs. This site is about a half mile upstream of the confluence with the Warm Springs Pond #2 discharge. The carefully contoured stream channel is well armored, and has a good diversity of riffle, run and pool habitats. The dominant green and blue-green algae present at station MW2 were essentially the same as those present downstream at Silver Bow Creek station 4.5, below the Warm Springs Ponds (Table 3). The red alga *Asterocystis* was also common at MW2 (Appendix A). These taxa indicate good water quality in the Mill-Willow Bypass in August 2000, that likely influences the algal assemblage downstream of the Warm Springs Ponds.

The non-diatom flora from **Warm Springs Creek near mouth (station 06)** was quite similar to those from Silver Bow Creek below the Warm Springs Ponds and the Mill-Willow Bypass, as well as Blacktail Creek and upper Silver Bow Creek (Table 3). The diverse periphyton assemblage comprised of the blue-greens *Nostoc* and *Oscillatoria,* the green algae *Cladophora* and *Oedogonium,* the golden alga *Vaucheria,* and the red alga *Audouinella* (Appendix A), along with very abundant diatoms, indicates Warm Springs Creek was contributing moderately rich, high quality water to the upper Clark Fork during August 2000.

The non-diatom algae at the **Clark Fork below Warm Springs Creek (station 07)** had much in common with Silver Bow Creek station 4.5, Warm Springs Creek station 06 and Mill-Willow Bypass station MW2, which join to form the Clark Fork a short distance upstream. The filamentous green algae *Cladophora* and *Oedogonium*, and the blue-greens *Nostoc* and *Oscillatoria* made up the bulk of the ten non-diatom taxa present at station 7. These algae again indicate relatively clean, nutrient-rich water at the headwaters of the Clark Fork. A distinct crust of calcium carbonate (marl), most likely related to the lime added at the head of the ponds, was present over much of the substrate.

The **Clark Fork near Dempsey (station 08)** had twelve dominant non-diatom algal taxa present in August 2000, the greatest number of any upper Clark Fork site (Figure 3). Growths of the filamentous green algae *Oedogonium, Stigeoclonium, Mougeotia* and *Cladophora* covered much of the riffle in a dirty green mat, along with numerous colonies of the blue-green alga *Nostoc*. The red alga *Audouinella* was also common at station 08 (Appendix A). This assemblage suggests rich water of relatively good quality, despite extensive flats of mill tailings (slickens) observed near the stream course. The Clark Fork has very little gradient through this reach and the riffle sampled, although quite shallow, was the only one available for a considerable distance above and below. The underside of cobbles at station 08 were stained a deep orange-red, possibly due to the presence of iron and manganese compounds.

Dominant non-diatom taxa at the **Clark Fork at Sager Lane (station 8.5)** dropped to seven from the high of twelve seen at station 08 (Figure 3). The filamentous green alga *Oedogonium* was less abundant, and the blue-green *Nostoc*, a fairly sensitive taxon, was no longer present. These relatively subtle changes suggest a worsening of water quality through this reach (Table 3). Stream banks above and below station 8.5 are in very poor shape, and efforts have been made to stabilize erosion with mesh and willow slip plantings, with only marginal success. Extensive tailings 'slickens' are present along this reach, and field observations indicate they continue to be undercut by the stream.

The number of dominant non-diatom genera decreased to only four at **Clark Fork at Deer Lodge (station 09)**, a low for the mainstem during 2000 (Figure 3). This suggests a continued worsening in water quality from that at upstream stations, although *Oedogonium* remained the most abundant non-diatom taxon. Diatom growth was heavy at station 09 (Table 3), and the diatom metrics may reveal reasons for the decline.

Due to fire-related travel restrictions it was necessary to relocate the **Clark Fork above the Little Blackfoot River (station 10)**, which previously was accessed from the Interstate 90 right-of-way. The closest vehicle access to the Clark Fork, about two miles upstream, was from Beck Hill Road at the former Kohrs Bend fishing access site (which is now closed due to the river undercutting the road). An adequate sample site with a riffle superior to the former location was identified about 150 meters upstream from the end of the road, at the head of the first island. It appeared that this site also would be usable during higher flows. Eight dominant non-diatom taxa were identified in 2000 at the new station 10, double the number seen at upstream station 09 (Figure 3). The blue-green algae (Cyanophyta), represented by *Nostoc* and *Calothrix*, edged out the green algae (Chlorophyta) for dominant phylum at station 10 (Table 3; Appendix A). However, as at all of the Clark Fork stations

above this point, the filamentous green algae *Oedogonium* and *Cladophora* were also strongly dominant. The red alga *Audouinella* was also one of the top five non-diatom taxon at station 10. The increase in diversity and number of non-diatom taxa at station 10 may indicate somewhat lower environmental stress and a slight improvement in water quality over station 09 in 2000. Diatoms were ranked fourth in estimated biovolume at station 10.

The **Little Blackfoot River near mouth (station 10.2)** had a diverse assemblage of 13 dominant non-diatom algae in 2000 (Figure 3, Appendix A). The five most important non-diatom taxa from the standpoint of biovolume are listed in Table 3, along with the diatoms. The colonial blue-green *Nostoc*, the filamentous golden alga *Vaucheria* (phylum Chrysophyta), and the filamentous green alga *Spirogyra* were the most important taxa in the Little Blackfoot River, and indicate cool, clean, high quality water in August 2000.

The **Clark Fork at Gold Creek bridge (station 11)** had eight dominant non-diatom algae present in 2000 (Figure 3), with a makeup of taxa similar to upstream station 10 (Table 3). Blue-green algae (phylum Cyanophyta) were dominant at station 11, and at least three of the taxa possessed the ability to fix atmospheric nitrogen. These blue-green algae would likely have a competitive advantage should nitrogen be the limiting algal nutrient in this reach. The phosphorous-rich Phosphoria Formation straddles the Clark Fork valley in this vicinity (Ingman *et al.* 1979), which further suggests nitrogen-limiting conditions in the Clark Fork through the Gold Creek reach. Diatoms were less important at station 11, ranking only fourth in estimated biovolume.

Flint Creek at New Chicago (station 11.5) had a relatively diverse algal assemblage of 12 dominant non-diatom taxa (Figure 3). The blue-greens *Nostoc* and *Oscillatoria* and the green alga *Cladophora* dominated the flora, with diatoms following at fourth in estimated biovolume (Table 4). The red alga *Audouinella* was also one of the top five non-diatom taxon at station 11.5 in 2000. These taxa suggest at least moderately rich conditions in Flint Creek during August of 2000. Degraded streambank conditions and heavy use of the stream bottom by cattle in the vicinity of station 11.5 are likely sources of elevated nutrients in Flint Creek.

Clark Fork at Bearmouth (station 11.7) had eleven dominant non-diatom taxa present, with the green algae (phylum Chlorophyta) well represented by *Oedogonium*, *Stigeoclonium* and *Cladophora* (Table 4). *Stigeoclonium* generally prefers elevated nutrient levels, possibly contributed to the reach by Flint Creek. *Nostoc* was also one of the most dominant algal taxa at station 11.7, as it had been at the majority of sites above this point on the river.

There were twelve dominant non-diatom taxa present in the **Clark Fork at Bonita (station 12)** (Figure 3), and the majority of these were green algae (Table 4). Compared to station 11.7, the green alga *Cladophora* increased in importance relative to the other algae, while *Oedogonium* decreased substantially. *Nostoc* did not occur as a dominant taxon at station 12 in 2000. These changes may indicate increased environmental stress on the algal community, possibly related to low flow or elevated water temperature.

Rock Creek near Clinton (station 12.5) had a fairly diverse assemblage of twelve non-diatom algae during August of 2000, that was quite similar to the floras of nearby Clark Fork stations (Figure 3, Table 4). The absence of alga phyla other than the Chlorophyta and Cyanophyta suggests that the biota in Rock Creek may have been under some degree of stress. Rock Creek's cold, clean, well-oxygenated water has typically supported a number of more sensitive genera, including the red alga *Lemanea* and the brown alga *Heribaudiella* (Weber 2000). The occurrence of *Stigeoclonium* as a dominant taxon suggests that nutrient levels may have been somewhat elevated during August 2000.

The **Clark Fork at Turah (station 13)** had eleven dominant non-diatom taxa present in August 2000, which were very similar in makeup to those at upstream stations 11.7 and 12 (Table 4, Figure 3). The green alga *Oedogonium*, which had occurred as a dominant taxon at every mainstem station in 2000 but had declined in importance at station 12, was absent from station 13. However, the brown alga *Heribaudiella* was common at station 13, which was the only mainstem site above Missoula where it occurred (Appendix A). Rock Creek may have had a slight positive influence on the algal flora at Clark Fork station 13 in 2000.

The **Blackfoot River near mouth (station 14)** had 13 dominant non-diatom taxa present, which tied for the greatest diversity seen in August 2000 (Figure 3). The presence of the blue-green genera *Oscillatoria*, *Dichothrix* and *Rivularia*, and the pollution-sensitive filamentous green genera *Chaetophora* and *Mougeotia* suggest clean, cold, and somewhat softer water in the Blackfoot River (Table 4). Additional taxa indicative of clean water were found in the Blackfoot River in 2000, including *Heribaudiella* and *Lemanea*, although they comprised relatively low numbers and biovolumes (Appendix A).

The **Clark Fork above Missoula (station 15.5)** had twelve dominant non-diatom taxa present during August of 2000 (Figure 3). The flora was similar in composition to upstream Clark Fork stations 11.7, 12 and 13, with *Cladophora*, *Nostoc* and *Phormidium* comprising much of the sample biovolume. However, the pollution-tolerant filamentous green *Stigeoclonium*, a dominant taxon at upstream sites, was essentially absent, while the filamentous green *Oedogonium* again became abundant (Table 4). These taxa indicate good water quality, likely due in large part to water contributed by Rock Creek and the Blackfoot River.

The **Clark Fork at Shuffields (station 18)** is located downstream of the Missoula Wastewater Treatment Plant discharge. Nine dominant non-diatom taxa were present at station 18, with *Phormidium*, *Cladophora*, *Stigeoclonium*, *Scenedesmus* and *Cosmarium* (and diatoms) accounting for essentially all of the algal biovolume at station 18. These taxa all tolerate, or even prefer somewhat elevated levels of algal nutrients. The absence at station 18 of relatively sensitive taxa found upstream at station 15.5, particularly *Oedogonium* and *Nostoc*, suggests an impact related to Missoula's wastewater, and possibly to non-point sources of pollution within the Missoula urban corridor.

Twelve dominant non-diatom genera were found in the **Bitterroot River near mouth (station 19)** during August of 2000 (Figure 3). The pollution-sensitive brown alga *Heribaudiella* was abundant,

and ranked second in biovolume only to the diatoms at station 19, while blue-green algae were altogether absent from the top five non-diatom taxa (Table 4). The algal taxa present suggest clean water with moderate levels of available algal nutrients.

The **Clark Fork at Harper Bridge (station 20)** had twelve dominant non-diatom taxa present in August 2000 (Figure 3). The green alga *Stigeoclonium* and the blue-green *Phormidium*, along with diatoms, were responsible for much of the algal biovolume at station 20, and indicate water relatively rich in algal nutrients (Table 4). However, both the red alga *Asterocystis* and the brown alga *Heribaudiella* were common, and suggest very good water quality at station 20 (Appendix A).

The **Clark Fork at Huson (station 22)** was not sampled in 2000 (see Methods, page 2).

The **Clark Fork near Superior (station 24)** had eleven dominant taxa present in August 2000 (Figure 3). The alga flora at station 24 was somewhat dissimilar to upstream station 20 (Table 4). *Cladophora*, *Oscillatoria* and *Chamaesiphon* were considerably more important at station 24, ranking first, second, and third in biovloume, respectively, while diatoms ranked only seventh. The red alga *Asterocystis* was somewhat more abundant at station 24, while the brown alga *Heribaudiella* was not present. Moderately rich water of good quality is suggested by all of these taxa, although the decline in relative importance of diatoms suggests some impairment. The Smurfit-Stone Corporation pulp mill is a considerable distance upstream of station 24, but downstream of station 20.

Dominant non-diatom algae at the **Clark Fork above the Flathead River (station 25)**, were identical in number and very similar in make-up to station 24 (Table 4, Figure 3). A notable difference between stations 24 and 25 is that diatoms increased dramatically in relative abundance and biovolume at the downstream site, to levels very typical of the majority of mainstem stations in August 2000. These taxa suggest relatively rich, largely unimpaired water in the lower Clark Fork.

The **Clark Fork above Thompson Falls Reservoir (station 27)** had 13 dominant algal genera present in August of 2000, more than any other lower Clark Fork station (Figure 3). The non-diatom algal flora was dominated by green algae, with the pollution-sensitive *Chaetophora* and *Spirogyra*, and the more tolerant *Cladophora*, *Cosmarium* and *Scenedesmus* making up the top five taxa by biovolume at station 27 (Table 4). This site is located below the confluence of the Flathead River with the Clark Fork, and the river is essentially twice the size and significantly different in chemical makeup.

Diatom Algae

The estimated abundance of diatom algae (all genera considered collectively) relative to non-diatom algal genera at the 27 Clark Fork and tributary stations monitored in 2000 are included in Tables 3 and 4, and in Appendix A. Diatoms are also ranked with non-diatom algal genera according to their estimated contribution to the total periphyton biovolume in each sample.

Diatoms were ranked at least "very common" at 26 of the 27 stations in 2000, with the remaining station receiving a "common" ranking (Tables 3 and 4, Appendix A). Diatoms were considered "dominant algae" at all 27 stations monitored in 2000, and were ranked first, second or third in estimated biovolume at 21 of the stations. Diatoms were not ranked below seventh in estimated biovolume at any Clark Fork or tributary station in 2000.

All diatom species identified during the floristic scans and proportional counts are listed alphabetically in Appendix B for the 2000 monitoring, with percent relative abundance (PRA) values for all diatom species tallied. Diatom species identified during the floristic scan, but not counted, are denoted as present with a letter "p". Lange-Bertalot pollution tolerance (PT) group assignments for each diatom species are also listed in Appendix B.

Major diatom species, here defined as all taxa that account for 10.0 percent or more of the diatom cells counted at one or more station, are listed in Table 6 for upper Clark Fork and tributary stations, and Table 7 for middle and lower Clark Fork and tributary stations.

Values for diatom **species richness** (number of species counted) at each station monitored during 2000 are listed in Tables 6 and 7. The total percent relative abundance of diatom taxa in each of the three Lange-Bertalot pollution tolerance groups at each station are listed in Appendix B.

Values for the **Shannon diversity index, pollution index, siltation index and disturbance index** calculated for each station for the 2000 monitoring are listed in Tables 6 and 7, and are plotted in Figures 5, 6 and 7, respectively.

Similarity Index (percent community similarity) values, calculated for adjacent stations on Silver Bow Creek and the Clark Fork mainstem, are listed in Table 6 and plotted in Figure 4.

Ratings for **biological integrity, overall impairment of aquatic life**, and **beneficial use support** for each of the 27 stations monitored in August 2000, as determined by criteria in Table 5, are listed in Tables 8 and 9.

Diatom Species Richness

With the exception of two Silver Bow Creek stations, diatom species richness values at all Clark Fork and tributary stations in 2000 were within the range of 23-51 species established by Bahls et al.

(1992) for least-impaired reference streams from mountain ecoregions. Species richness was 29 or less at three of the 27 stations in 2000, but only two of those stations had fewer than 20 species and were considered to suffer more than minor impairment (Tables 6 and 7). The two lowest diatom species richness values during August 2000 were found in the reach of Silver Bow Creek above the Warm Springs Ponds. **Silver Bow Creek below Lower Area One** (the former Colorado Tailings) **(station 01)** and **Silver Bow Creek at Opportunity (station 2.5)** had 19 and 16 species tallied, respectively (Table 6), indicating moderate impairment with partial support of aquatic life uses according to criteria in Table 5. **Silver Bow Creek above the Butte WWTP (station 00)** had 26 diatom species counted, indicating minor impairment of aquatic life but full support of aquatic life uses (Table 6). The remaining 23 Clark Fork and tributary stations had species richness values ranging from 30 to 52, with no impairment of aquatic life beneficial uses indicated (Tables 6 and 7).

Diversity Index

The Shannon diversity index fell within or exceeded the range of 2.16-4.50 determined for least-impaired reference streams by Bahls et al. (1992) at all 27 stations monitored in 2000 (Tables 6 and 7, Figure 5). Three stations had diversity index values within the range 2.00-2.99 that indicates minor aquatic life impairment (Table 5). The low diversity index values were at **Silver Bow Creek below Lower Area One** (the former Colorado Tailings) **(station 01), Silver Bow Creek at Opportunity (station 2.5)** and **Clark Fork at Deer Lodge (station 09)** (Tables 6 and 7, Figure 5).

The remaining 24 stations had Shannon diversity values that exceeded 2.99 (Tables 6 and 7). The highest diversity index value, 4.88, occurred at **Clark Fork below Warm Springs Creek (station 07)**, which is only a short distance downstream of the confluence of the Mill-Willow Bypass and Warms Springs Pond 2 Discharge, as well as Warm Springs Creek. The "coming together" of these three streams likely contributed to the very high diversity index value at station 07.

Pollution Index

Pollution index values at 20 of 27 Clark Fork Basin stations monitored in 2000 were within the range of 2.45-2.94 determined by Bahls et al. (1992) for least-impaired reference streams. At 18 of the 27 sites monitored in 2000, pollution index values exceeded 25 and were considered unimpaired and fully supportive of aquatic life uses (Table 6 and 7, Figure 6).

Severe impairment of aquatic life, with non-support of beneficial aquatic life uses, was indicated at **Silver Bow Creek below Lower Area One** (the former Colorado Tailings) **(station 01)** and **Silver Bow Creek at Opportunity (station 2.5)** in August 2000 (Table 6). The low pollution index values were a direct result of the Butte municipal wastewater discharge, and large deposits of historical mine and mill tailings in the Silver Bow Creek floodplain between Butte and Opportunity, upstream of the Warm Springs treatment ponds.

Pollution index values at an additional seven sites in 2000 indicated minor impairment of aquatic life, with full support of beneficial uses (Tables 6 and 7). These included **Blacktail Creek above Grove Gulch (station SF-1), Silver Bow Creek above the Butte WWTP (station 00)**, and **Silver Bow Creek below Warm Springs Ponds (station 4.5)** in the Silver Bow Creek drainage at the Clark Fork headwaters. In the upper Clark Fork, pollution index values indicated minor impairment at **Clark Fork at Dempsey (station 08), Clark Fork at Sager Lane (station 8.5)** and **Clark Fork at Deer Lodge (station 09)**, while in the middle reach of the Clark Fork between the Little Blackfoot River and Missoula, minor impairment was indicated at **Clark fork at Turah (station 13)**.

Siltation Index

The siltation index has the opposite response to degraded conditions that is seen with the diversity index and pollution index: that is, the higher the value the worse the siltation problem. Siltation index values at 25 of the 27 sites monitored in 2000 were within the range of 0.0-50.3 determined by Bahls et al. (1992) (Figure 7). The highest siltation index value determined for 2000 was at **Silver Bow Creek at Opportunity (station 2.5)**, where severe impairment of aquatic life with non-support of beneficial uses was indicated (Table 6, Figure 7).

Eleven stations had siltation index values that indicated moderate impairment, with only partial support of beneficial uses, according to criteria in Table 5 (Tables 6 and 7). These include: in the Silver Bow Creek drainage, **Silver Bow Creek below Lower Area One** (the former Colorado Tailings) **(station 01), Silver Bow Creek below Warm Springs Creek (station 4.5)** and **Warm Springs Creek near mouth (station 06)**; in the upper Clark Fork reach, **Clark Fork below Warm Springs Creek (station 07)** and **Clark Fork near Dempsey (station 08)**; in the middle Clark Fork reach, **Flint Creek at New Chicago (station 11.5), Rock Creek near Clinton (station 12.5)** and **Clark Fork at Turah (station 13)**; and in the lower Clark Fork reach, **Clark Fork above Missoula (station 15.5), Clark Fork at Shuffields (station 18)** and **Clark Fork at Harper Bridge (station 20)**.

Ten stations had siltation index values indicating minor impairment of aquatic life, but fully supporting beneficial aquatic life uses (Tables 6 and 7). The majority of these stations are located in the upper and middle Clark Fork reaches, and only one is downstream of Missoula. These include: in the Silver Bow Creek drainage, **Blacktail Creek above Grove Gulch (station SF-1)** and **Silver Bow Creek above Butte WWTP (station 00)**; in the upper Clark Fork reach, **Clark Fork at Sager Lane (station 8.5), Clark Fork at Deer Lodge (station 09), Clark Fork above Little Blackfoot River (station 10)** and **Little Blackfoot River near mouth (station 10.2)**; in the middle Clark Fork reach, **Clark Fork at Gold Creek Bridge (station 11), Clark Fork at Bearmouth (station 11.7)** and **Clark Fork at Bonita (station 12)**; and in the lower Clark Fork reach, **Clark Fork above the Flathead River (station 25)**.

Only the five remaining stations were rated as unimpaired, and fully supported of aquatic life uses from the standpoint of siltation. Of the five, three were tributaries and only one was upstream of the Blackfoot River (Tables 6 and 7).

Individual Site Assessments

Each of the 27 mainstem and tributary stations sampled in August of 2000 are rated for **biological integrity** and **overall impairment of aquatic life**, as well as to the degree of **beneficial use support** in Tables 8 and 9, according to the seven criteria listed in Table 5. Assessments of Clark Fork Basin monitoring sites are essentially the same as those done in the past under bioassessment Protocol I (Weber 1993, 1995, 1996, 1997, 1998 and 1999), and a minimum score that corresponds to criteria in the last column of Table 5 is included with the ratings in Tables 8 and 9. Similarity index (percent community similarity) values of the diatom floras at adjacent mainstem Silver Bow Creek and Clark Fork sites are plotted in Figure 4 and listed in Tables 6 and 7, and are used to assess change between stations where possible. Temporal trends in the pollution index at each station over the last twelve years are plotted in Figures 8-35.

Blacktail Creek above Grove Gulch (station SF-1)

Based on metrics in Table 6 and the assessment criteria in Table 5, biological integrity in Blacktail Creek at **station SF-1** in August of 2000 was rated good, with minor impairment of aquatic life indicated due to slightly depressed pollution index and slightly elevated siltation index values. The diatom metrics indicate Blacktail Creek fully supports beneficial aquatic life uses.

The major diatom taxa, *Achnanthes lanceolata* and *Fragilaria crotonensis,* indicate cool, well-oxygenated, slightly alkaline water with moderate nutrient levels of at **station SF-1** in August 2000. The stream bottom of Blacktail Creek is composed primarily of shifting granitic sands, and except for a section of large cobbles and boulders at the mouth of the large Interstate highway culvert, stable substrates are rare. This artificial "riffle" is the only habitat available for macroinvertebrate sample collection, and a significant portion of the periphyton sample was collected from these rocks as well. The diatom algae identified from Blacktail Creek may reflect the creek's potential if adequate benthic substrate was available.

Pollution index values for Blacktail Creek at **station SF-1** for August of the years 1993-2000 are plotted in Figure 8. The 2000 value was the highest yet determined over the period of record. A trend for increasing pollution index values in Blacktail Creek since 1998 suggests some improvement in water quality over the last three years.

Silver Bow Creek above Butte WWTP (station 00)

Biological integrity at Silver Bow Creek **station 00** was rated good, with only minor impairment of aquatic life due to a depressed pollution index value and a slightly elevated siltation index value (Table 6). Beneficial uses of aquatic life were fully supported in August 2000, according to criteria in Table 5.

The major diatom taxa present at Silver Bow Creek **station 00**, most notably *Cyclotella meneghiniana* and *Nitzschia palea*, tolerate or even prefer elevated levels of nitrogen. Just prior to the 1998 sample collection, Silver Bow Creek was relocated into a newly constructed stream channel skirting the former Colorado Tailings site. Fertilizer applied to promote growth of ground cover and streambank vegetation may be the source of elevated nitrogen in this reach. In August 2000 the channel appeared to be developing attributes of a natural stream course. Riparian vegetation was established, and stream banks were relatively stable. A considerable amount of sand was evident in the stream bottom, which also supported well established beds of rooted macrophytes, especially *Ranunuculus*.

The percent community similarity between diatom floras from Silver Bow Creek **station 00** and Blacktail Creek **station SF-1** upstream, indicate somewhat dissimilar floras and moderately different water quality between these stations in 2000 (Tables 5 and 6, Figure 4).

Pollution index values for Silver Bow Creek **station 00** over the period 1989-2000 are plotted in Figure 9. The 2000 pollution index value increased significantly over 1999, and was comparable to 1998, the first year the reclaimed channel was monitored. Water quality and biological integrity at **station 00** appear to have improved significantly in response to Superfund remediation efforts, particularly compared to the very poor period of 1995-1997 (Figure 9).

Silver Bow Creek below Lower Area One (the former Colorado Tailings) **(station 01)**

Biological integrity was rated as poor, with severe impairment of aquatic life at Silver Bow Creek **station 01** during 2000 (Table 8). Beneficial uses of aquatic life were not supported at station 01, as indicated by a very low pollution index value and an elevated siltation index value (Table 6, Figures 6 and 7).

The major diatom species at **station 01** included *Gomphonema parvulum*, *Navicula minima* and *Nitzschia palea*, all pollution-tolerant (PT group 1) taxa that are indicative of highly degraded water quality. The severe impairment of aquatic life indicated at Silver Bow Creek **station 01** is primarily the result of excessive biogenic waste loading from the Butte Metro Wastewater Treatment Plant, with the likely addition of toxic metals and sediments from the floodplain.

The percent community similarity between Silver Bow Creek **station 01** and upstream **station 00** for 2000 indicate somewhat dissimilar diatom floras, with a moderate change between the stations (Tables 5 and 6, Figure 4).

Pollution index values at Silver Bow Creek **station 01** over the twelve year period of record are the lowest of any station in the Clark Fork Basin (Figure 10). The August 2000 value for pollution index, while slightly improved over the previous year, was below the mean value for **station 01** (Figure 36). While the trend is for improvement over the extremely low value seen in 1998, water quality continues to be very poor in Silver Bow Creek below Lower Area One.

Silver Bow Creek at Opportunity (station 2.5)

During August of 2000, biological integrity at Silver Bow Creek **station 2.5** was rated as poor, with severe impairment of aquatic life indicated (Table 8). The second lowest pollution index value, and the highest siltation index value determined in 2000 resulted in the poor rating (Table 6, Figures 6 and 7). The diversity index value for **station 2.5** was the second lowest determined during August 2000, only slightly greater than at upstream station 01 (Table 6, Figure 5), but indicated only minor impairment according to the criteria in Table 5.

Major diatom taxa at **station 2.5** included *Navicula minima* and *Nitzschia palea* (Table 6). Both species belong to pollution tolerance (PT) group 1, and are highly tolerant of organic wastes and heavy metals.

The similarity index value between Silver Bow Creek **station 01** and **station 2.5** indicated somewhat similar floras in 2000, with only minor change between the sites. (Table 6, Figure 4).

Pollution index values determined for **station 2.5** since 1989 are plotted in Figure 11. The pollution index for 2000 decreased greatly from the 1999 value, strongly affirming a trend that followed the relatively high pollution index value at **station 2.5** in 1997 (Figure 11). The 2000 pollution index value for **station 2.5** dropped to below the mean value for the period of record (Figure 36).

Mill-Willow Bypass near mouth (station MW2)

The re-established station on the Mill-Willow Bypass was rated as having excellent biological integrity with unimpaired aquatic life that fully supported beneficial aquatic life uses (Table 8).

Major diatom species at **station MW2** indicated slightly alkaline water with moderate levels of algal nutrients. *Cocconeis pediculus* was likely an epiphyte on the abundant rooted macrophytes.

Previous monitoring of the Mill-Willow Bypass from 1989 to 1992 was conducted in the original stream channel, which contained significant historic deposits of mill tailings. Following the removal of tailings and extensive channel reconstruction work, **station MW2** was established as part of the EPA and ARCO Superfund monitoring program, and was added to this program in 1999. Pollution index values from the years 1989-1992 suggest dramatic improvement in water quality through this period (Figure 12). The 1999 and 2000 pollution index values were determined from diatom data collected in the new channel. The 2000 pollution index value exceeds the mean for the period of record, and indicates improving water quality at **station MW2** (Figure 37).

Silver Bow Creek below Warm Springs Ponds (station 4.5)

The Warm Springs Ponds serve to remove dissolved and sediment-born heavy metals from upper Silver Bow Creek through the process of lime addition and sedimentation. Biological integrity at Silver Bow Creek **station 4.5**, below the Warm Springs Ponds, was rated as only fair during August of 2000, with moderate impairment of aquatic life impairment indicated due to an elevated siltation index value (Tables 6 and 8). Beneficial aquatic life uses were only partially supported. The reason for the high siltation index at **station 4.5** is not readily apparent, but may be related to inadequate flushing flows during the spring of 2000.

Major diatom species at **station 4.5** included *Epithemia sorex* and *Nitzschia fonticola*, both fairly sensitive forms that prefer somewhat alkaline, nutrient-rich water.

Percent community similarity between **station 4.5** and **station 2.5** upstream of the Warm Springs Ponds was extremely low during 2000, indicating a major change in the diatom flora downstream of the treatment ponds (Table 6, Figure 4). Based on the other diatom metrics, it is obvious that water quality at **station 4.5** is much improved over station 2.5, and that the Warm Springs Ponds system is responsible for these improvements. It should be noted that the Mill-Willow Bypass enters the Warm Springs Pond #2 discharge (Silver Bow Creek) upstream of **station 4.5**, and likely influences the make up of the periphyton assemblage at Silver Bow Creek **station 4.5.**

Pollution index values for **station 4.5** for the period 1989-2000 are plotted in Figure 13. The 2000 value was only slightly lower than the relatively high value determined in 1999, and missed an unimpaired rating by a narrow margin. A significant trend for improvement in the pollution index seen over the previous three years appears to have leveled off. The low value seen in 1997 possibly was the result of higher streamflows during August of that year that may have reduced the pond system's treatment efficiency, causing increased sediment and/or heavy metals impacts at station 4.5 (Weber 1999). These impacts did not appear in 1999 and 2000, when streamflows were considerably lower.

Warm Springs Creek near mouth (station 06)

Biological integrity at Warm Springs Creek **station 06** during August of 2000 was rated only fair, with moderate impairment of aquatic life indicated due to an elevated siltation index value (Tables 5 and 6). Diversity and pollution index values at **station 06** during 2000 indicated the biota was unimpaired, and aquatic life beneficial uses were fully supported (Table 8).

The major diatom taxa at **station 06** in August 1999 are pollution-sensitive forms that prefer cold, well-oxygenated water. *Cymbella silesiaca* and *Nitzschia dissipata* were the dominant taxa (Table 6).

Pollution index values at Warm Springs Creek **station 06** for the years 1989-2000 are plotted in Figure 14. The 2000 value decreased slightly from the high determined in 1999, ending an upward trend emerging since 1997. The 2000 was slightly higher than the mean value for the period of record (Figure 37).

Clark Fork reach 1 (CFR1)

Five upper Clark Fork stations comprised CFR1 in 1999: **Clark Fork below Warm Springs Creek (station 07), Clark Fork near Dempsey (station 08), Clark Fork at Sager Lane (station 8.5) Clark Fork at Deer Lodge (station 09)** and **Clark Fork above the Little Blackfoot River (station 10)**.

At **station 07** and **station 08**, biological integrity was rated as fair in August 2000, with moderate impairment of aquatic life due to elevated siltation index values (Table 6, Figure 7). Beneficial aquatic life uses were only partially supported at these two Clark Fork stations (Table 8). Biological integrity was rated as good at **station 8.5, station 09** and **station 10,** with minor impairment of aquatic life due to slightly depressed pollution index values and slightly elevated siltation index values at the first two, and to an elevated siltation index at the later (Table 6, Figure 7). The Shannon diversity value at **station 09** was at the cutoff for minor impairment (Table 6).

The similarity index value between **station 07** and upstream station 4.5 indicated somewhat similar diatom floras, with only minor change between the sites (Table 6, Figure 4). **Station 07** and **station 08** had diatom floras that were very similar with no change between them, while **station 08** and **station 8.5** had diatom floras that were somewhat dissimilar with moderate change indicated (i.e., a possible worsening of water quality at **station 8.5**). Diatom floras were very similar between **station 8.5** and **station 09**, with no change between the sites, while between **station 09** and **station 10** moderate change was indicated by somewhat dissimilar diatom floras (Table 6, Figure 4). The similarity index values suggest that considerable change occurs in reach **CFR1**.

Epithemia sorex was the major diatom taxon at **station 07, station 08** and **station 10** (Table 6), suggesting nitrogen-limited conditions may have existed at these sites, as *E. sorex* harbors endosymbiotic nitrogen-fixing blue-green algae (Cyanobacteria) within the cell walls. At **station 8.5** and **station 09**, *Achnanthes minutissima* and *Synedra ulna* were the dominant taxa, indicating poorer water quality and greater environmental stress on the diatom community at these stations.

Pollution index values for the period of record at each of the **CFR1** stations are plotted in Figures 15-19. Values during August 2000 for **station 07** and **station 10** are little changed from the relatively high values seen the previous year, while values for **station 08, station 8.5** and **station 09** declined somewhat from the 1999 values. The mean pollution index for **CFR1** during August 2000 was slightly higher than the mean for the reach over the period of record (Figure 38), suggesting a slight general improvement in water quality in the upper Clark Fork over time.

Little Blackfoot River near mouth (station 10.2)

Biological integrity at **station 10.2** on the Little Blackfoot River in August 2000 was rated as good, with minor aquatic life impairment due to a slightly elevated siltation index value (Table 6, Figure 7). Beneficial aquatic life uses were fully supported (Table 8). Diversity index and pollution index values indicated unimpaired biota with excellent biological integrity at **station 10.2** in August 2000 (Table 6).

Several diatom taxa were dominant at **station 10.2** in August 2000 (Table 6). All of these taxa prefer slightly alkaline, moderately nutrient-rich, well-oxygenated flowing water.

Pollution index values at Little Blackfoot River **station 10.2** for the period 1993-2000 are plotted in Figure 20. The 2000 pollution index value at **station 10.2** increased over the 1999 value, and exceeded the mean value for the period of record (Figure 37). Values have fluctuated slightly over the eight years **station 10.2** has been monitored, falling slightly into either the unimpaired or minor impairment range. The relatively high-quality water from the Little Blackfoot River continues to be an important contribution to the Clark Fork.

Flint Creek at New Chicago (station 11.5)

Biological integrity at **station 11.5** was rated as fair during August 2000, with moderate impairment of aquatic life due to an elevated siltation index value (Table 7). Beneficial aquatic life uses were only partially supported at **station 11.5** (Table 9). However, the diversity index and pollution index values were both relatively high and indicated unimpaired aquatic life at **station 11.5** in August 2000 (Table 7).

There were no diatom taxa that accounted for 10.0 percent or more of the total cells counted at Flint Creek **station 11.5** in 2000. The diatom metrics indicate that the flora was comprised largely of pollution sensitive taxa that were somewhat tolerant of sediment. All diatom taxa identified at **station 11.5** are listed in Appendix B.

Flint Creek has serious problems related to agriculture and poor streambank conditions that contribute to nutrient enrichment and sediment problems in its lower reaches. Pollution index at **station 11.5** rebounded in 2000 from the fairly low value determined in 1999, to a level very near the mean for the period of record (Figure 22 and 38).

Clark Fork reach 2 (CFR2)

The four stations that comprise **CFR2** include **Clark Fork at Gold Creek Bridge (station 11), Clark Fork at Bearmouth (station 11.7), Clark Fork at Bonita (station 12),** and **Clark Fork at Turah (station 13)**. Biological integrity was rated as good at **station 11, station 11.7** and **station**

12 in August 2000, with only minor impairment of aquatic life due to slightly elevated siltation index values. The siltation index value **station 13** was considerably higher, resulting in a moderate impairment rating (Tables 6- 9, Figure 7). By comparison, diversity index and pollution index values indicated unimpaired aquatic life at all four **CFR2** stations (Tables 6 and 7). Beneficial aquatic life uses were fully supported at all **CFR2** stations except **station 13**, where beneficial uses were only partial supported.

The diatom floras at **station 11** and **station 11.7** were somewhat similar to one another, with minor change indicated between the stations in August 2000 (Table 7, Figure 4). These mainstem sites are above and below the confluence of Flint Creek. The similarity index between **station 11.7** and **station 12** was over 70 percent, indicating very similar diatom floras. However, the similarity index between **station 12** and **station 13** was only about 37 percent, indicating somewhat dissimilar floras and moderate change between the sites. Again, an intervening tributary, Rock Creek, likely influenced the makeup of the diatom flora at the downstream station.

Epithemia sorex was the dominant diatom taxon at **station 11, station 11.7** and **station 12** in August 2000 (Tables 6 and 7). *E. sorex* has a competitive advantage in waters that are nitrogen-limited (in this case due to naturally high levels of available phosphorus) in that it harbors endosymbiotic nitrogen-fixing blue-green algae (Cyanobacteria) within its frustule. The dominant diatom species at **station 13** was *Nitzschia paleacea,* a cosmopolitan form tolerant of moderate nutrient enrichment but preferring well-oxygenated, circumneutral water. *E. sorex* was not a major species **station 13**.

Pollution index values at **stations 11, 11.7, 12 and 13** for the period of record are plotted in Figures 21, 23, 24 and 26, respectively. At **station 11,** the pollution index in 2000 was slightly higher than the 1999 value. Values at **stations 11.7, 12** and **13** in 2000 were somewhat lower than the high values seen in 1999. Of the four stations in **CFR2**, only **station 13** had a pollution index value that was less than the mean value for the period of record (Figure 36). The mean pollution index value in August 2000 for reach **CFR2** was slightly less than the mean for the period of record (figure 38).

Rock Creek near Clinton (station 12.5)

Biological integrity at Rock Creek **station 12.5** in August 2000 was rated only fair, with moderate impairment of aquatic life indicated due to an elevated siltation index value (Table 7). Based on this rating, beneficial aquatic life uses in Rock Creek were only partially supported. The credibility of this lower rating may be questionable, as the diversity index and pollution index values in 2000 indicated an unimpaired biota with full support of beneficial uses (Table 7).

The dominant diatom species at Rock Creek **station 12.5** in 2000 were *Nitzschia fonticola* and *Nitzschia paleacea* (Table 7), forms preferring cool, well-oxygenated, circumneutral water but indicative of moderate nutrient enrichment.

Pollution index values for **station 12.5** over the eight years of record are consistently over 2.50, reflecting the dependably high water quality in Rock Creek (Figure 25). The 2000 pollution index value for **station 12.5** was at the mean value for the period of record at (Figure 37).

Blackfoot River at USGS Station near mouth (station 14)

The Blackfoot River **station 14** was rated as unimpaired with excellent biological integrity in August 2000, based on the diatom metrics in Table 7 and criteria in Table 5.

Major diatom species at **station 14** included *Achnanthes minutissima* and *Cymbella affinis* (Table 7). *A. minutissima* prefers cold, well-oxygenated water, and often is a colonizing species following a spate or physical disturbance, while *C. affinis* is commonly found in moderately rich, slightly alkaline waters, particularly in medium to large-sized rivers. Both taxa belong to pollution tolerance group 3.

Pollution index values at Blackfoot River **station 14** for the twelve years 1989-2000 were very stable and well above 2.5 (Figure 27), indicating consistently high-quality, unpolluted water in this major tributary to the Clark Fork. The pollution index value at **station 14** during August 2000 was slightly lower than the very high value recorded in 1999, as well as the mean value for the period of record (Figure 38).

Clark Fork reach 3 (CFR3)

Two stations, the **Clark Fork above Missoula (station 15.5)**, and the **Clark Fork at Shuffields (station 18)** make up reach CFR3. In August 2000, both **station 15.5** and **station 18** were rated as having only fair biological integrity with moderate impairment of aquatic life due to elevated siltation index values (Table 7, Figure 7). Based on this rating, beneficial aquatic life uses at both **station 15.5** and **station 18** were only partially supported in August 2000. These ratings were not supported by the diversity index and the pollution index values, which indicated unimpaired aquatic life at both stations (Table 7).

The similarity index value between **station 15.5** and upstream Clark Fork **station 13** was about 54 percent for 2000, indicating somewhat similar diatom floras at the Clark Fork sites above and below the Blackfoot River (Tables 5 and 7) . **Station 15.5** and **station 18** had a similarity index of about 58 percent during August 2000, again indicating somewhat similar diatom floras and only minor change between the stations. The dominant diatom species at **station 15.5** was *Achnanthes minutissima*, while **station 18** had *Cymbella affinis* as the dominant taxon (Table 7). These differences likely reflect somewhat warmer and richer water at **station 18**. These stations bracket the "urban" reach of the Clark Fork that flows through the city of Missoula and receives the Missoula WWTP discharge, factors that undoubtedly have an influence on water quality.

Pollution index values for **station 15.5** above Missoula have been quite constant over the twelve-year period from 1989 to 2000 (Figure 28), and indicated generally unimpaired water quality in the Clark Fork just below the Blackfoot River and Milltown Dam. At **station 18**, pollution index values were slightly more variable over the twelve years, but generally exceeded 2.5 indicating unimpaired water quality from the standpoint of organic pollution (Figure 29). The August 2000 pollution index values at both **station 15.5** and **station 18** were less than the mean value for the period of record (Figure 36). The pollution index value for reach **CFR3** in August 2000 was less than the mean value over the period of record (Figure 38), suggesting a slight worsening of water quality in the reach.

Bitterroot River near mouth (station 19)

Bitterroot River **station 19** was rated as having excellent biological integrity with unimpaired aquatic life during August of 2000, based on diatom metrics in Table 7 and criteria in Table 5. The pollution index value at **station 19** for August 2000 was slightly less than the very high value recorded in 1999 (Figure 30), but exceeded the mean value for the twelve-year period of record (Figure 37).

The dominant diatom species at **station 19** in August 2000 was *Achnanthes minutissima*, with *Cymbella affinis* as a major species (Table 7). These taxa indicate cool, well-oxygenated water. This large tributary continues to have a positive impact on water quality in the Clark Fork.

Clark Fork reach 4 (CFR4)

The **Clark Fork at Harper Bridge (station 20)**, and the **Clark Fork at Huson (station 22)** are usually included in reach **CFR4**, but due to travel restrictions related to the extreme fire danger, **station 22** could not be accessed in 2000, and alternatives were also inaccessible. **Station 20** was rated as having only fair biological integrity in 2000 with moderate impairment of aquatic life (Tables 5 and 9). The moderate impairment at **station 20** was due to an elevated siltation index value, although the site would be considered unimpaired based on the other diatom metrics (Table 7). **Station 20** only partially supported beneficial aquatic uses during August 2000 (Table 9).

Cymbella affinis was the dominant taxon at **station 20**, while *Navicula capitatoradiata was* a major species (Table 7). Both species are common in the summer in larger streams having moderately rich, circumneutral water.

Pollution index values at Harper Bridge **station 20** over the period 1989-2000 have remained above 2.5, although the 2000 value just did, and was considerably lower than the 1999 value and the mean for the period of record (Figures 31 and 36). The "mean" pollution index value for **CFR4** during August 2000, actually a single sample value, was lower than the mean for reach **CFR4** over the period of record (Figure 38).

Clark Fork reach 5 (CFR5)

The **Clark Fork near Superior (station 24)**, and **Clark fork above the Flathead River (station 25)** comprise reach **CFR5**. Biological integrity was rated as excellent with unimpaired aquatic life at **station 24**, and good with minor aquatic life impairment at **station 25** during August 2000 (Table 9). Beneficial aquatic life uses were fully met at both stations (Table 9). A very slightly elevated siltation index value was responsible for the minor impairment rating at **station 25**.

Community similarity between **station 24** and **station 25** was over 75 percent during August 2000, indicating very similar floras and essentially no change between these stations (Tables 5 and 7, Figure 4). Major diatom species at both stations included *Cocconeis placentula* and *Cymbella affinis.*

Pollution index values at Clark Fork **station 24** and **station 25** have remained quite high over the period 1989-2000, declining very slightly in 2000 from the 1999 values, which are the highest for the period of record in (Figures 33 and 34). The mean pollution index value for **CFR5** during August 2000 was essentially equal to the mean for the reach over the period of record (Figure 38).

Clark Fork above Thompson Falls Reservoir (station 27)

Biological integrity at Clark Fork **station 27**, above Thompson Falls Reservoir, was rated as excellent with no aquatic life impairment during August 2000 (Tables 7 and 9), and beneficial aquatic life uses were fully met. The siltation index value at **station 27** was the second lowest measured at any Clark Fork Basin station during August 2000 (Table 7, Figure 7). The pollution index at **station 27** over the period 1989-2000, with but one exception has exceeded 2.5, and did so in 2000, although the value was less than the mean for the period of record (Figure 35). The diatom flora and metrics indicate continued unpolluted conditions in this very large river.

<u>Longitudinal Trend Assessments</u>

Pollution index values for August 2000, and long-term mean values for August of 1989-2000 (fewer years for several stations) at 20 mainstem stations on Blacktail Creek, Silver Bow Creek and the Clark Fork mainstem, are plotted in Figure 36. Pollution index values for selected tributary streams to the Clark Fork during August 2000, and mean values for the period of record for each station are plotted in Figure 37. Mean pollution index values for Silver Bow Creek and Clark Fork reaches during August 1999, and for the period of record for each reach are plotted in Figure 38. Stations or reaches with pollution index values that exceeded the long term mean had somewhat improved water quality during August 2000, while those with values less than the mean likely saw a worsening of water quality.

At Blacktail Creek **station SF-1** in Silver Bow Creek headwaters, and at Silver Bow Creek **station 00** above the Butte WWTP, the pollution index value in 2000 exceeded the long-term mean value (Figure 36). At Silver Bow Creek **station 01** below the Colorado Tailings, and Silver Bow Creek **station 2.5** at Opportunity, pollution index values in August 2000 were less than the twelve-year mean. Silver Bow Creek **station 4.5** below the Warm Springs Ponds had a pollution index value in 2000 that was considerably greater than the long-term pollution index value (Figure 36). In the Silver Bow Creek reach comprised by the three stations upstream of the Warm Springs Ponds, the mean pollution index for August 2000 was slightly less than the average for the period of record (Figure 38).

For the five stations within Clark Fork reach 1 (**CFR1**), **station 07** below Warm Springs Creek, **station 08** near Dempsey, and **station 10** above the Little Blackfoot River had pollution index values that were slightly greater than the mean value for the period of record, while **station 8.5** at Sager Lane and **station 09** at Deer Lodge had values during August 2000 that were less than the mean (Figure 36). The mean pollution index value for **CFR1** during August 2000 was essentially at the long-term average (Figure 38).

In Clark Fork reach 2 (**CFR2**), **station 11** at Gold Creek Bridge had a pollution index value in 2000 that was slightly greater than the long-term mean, while **station 11.7** at Bearmouth and **station 12** at Bonita had 2000 values at, or very slightly below, long-term means (Figure 36). **Station 13** at Turah had a pollution index value in 2000 that was considerably less than the mean for the period of record (Figure 36). The mean pollution index value for **CFR2** during August 2000 was slightly lower than the mean for the period of record, indicating poorer water quality in 2000 (Figure 38).

Within Clark Fork reach 3 (**CFR3**), both **station 15.5** above Missoula and **station 18** at Shuffields had pollution index values that were somewhat less than average in August 2000 (Figure 36). Reach **CFR3,** therefore, had a mean pollution index value during August 2000 that was less than the long-term average for the twelve years of record (Figure 38).

Clark Fork reach 4 (**CFR4**) consisted of two stations, **station 20** at Harper Bridge and **station 22** at Huson, for previous year's assessments. However, **station 22** could not be sampled in 2000, so reach 4 will be considered as **station 20** alone. As with the two stations upstream in reach 3, the pollution index value at **station 20** (and **CFR4**) in August 2000 was less than the long-term mean value (Figures 36 and 38).

Station 24 near Superior and **station 25** above the Flathead River in Clark Fork reach 5 (**CFR5**) had pollution index values in 2000 that were at the twelve-year mean values (Figure 36), as did **CFR5** (Figure 38). The pollution index at **Station 27** above Thompson Falls Reservoir was somewhat below average for August 2000 (Figure 36).

For upper Clark Fork Basin tributaries, the August 2000 pollution index value exceeded the long-term mean value at Blacktail Creek **station SF-1**, Mill-Willow Bypass **station MW2** and Silver Bow Creek **station 4.5,** while at Warm Springs Creek **station 06** the pollution index was very near average

(Figure 37). Of the three middle Clark Fork tributaries, Little Blackfoot River **station 10.2** and Flint Creek **station 11.5** had pollution index values were slightly greater than average, while the value at Rock Creek **station 12.5** was average for August 2000 (Figure 37). The pollution index at Blackfoot River **station 14** during August 2000 was slightly below the long-term average, while Bitterroot River **station 19** was somewhat greater than the mean for the years 1989-2000 (Figure 37).

Table 3. Estimated relative abundance of algal cells and rank by volume ( ) of diatoms and the five most abundant non-diatom genera in periphyton samples collected from monitoring sites on the upper Clark Fork and tributaries during August 2000. VA = very abundant, A = abundant, VC = very common, C = common.

taxa	stream/ station:	BTC SF-1	SBC 00	SBC 01	SBC 2.5	MWB MW2	SBC 4.5	WSC 06	CFR 07	CFR 08	CFR 8.5	CFR 09	CFR 10	LBR 10.2	CFR 11
Chlorophyta (green algae)															
Ankistrodesmus						VA(6)									
Cladophora			A(2)			VC(1)	VC(5)	C(5)	VC(4)	C(5)	C(3)	VC(3)	VC(3)		VC(2)
Closterium		C(5)							C(6)						
Cosmarium					C(3)										
Enteromorpha			VC(4)												
Gloeocystis			VA(1)	VA(3)											
Microspora		VA(3)													
Mougeotia										VC(6)					
Oedogonium		VA(1)				VC(3)	VC(4)	A(2)	A(3)	A(2)	C(5)	A(2)	A(1)	VC(5)	VC(3)
Pediastrum											C(6)				
Rhizoclonium		C(6)													
Scenedesmus			A(6)	VC(6)	VA(1)										
Spirogyra														A(4)	
Stigeoclonium				A(4)			A(6)			A(4)	A(2)	C(4)			
Chrysophyta (golden algae)															
Diatoms (Bacillariophyceae)		VA(2)	VA(3)	VA(1)	C(4)	VA(2)	VA(3)	VA(1)	VA(2)	VA(1)	VA(1)	VA(1)	VC(4)	VA(3)	A(4)
Tribonema				A(5)											
Vaucheria		VC(4)		A(2)				VC(4)						A(2)	
Cyanophyta (blue-green algae)															
Calothrix													A(5)		
Nostoc						A(4)	VA(1)	A(3)	VA(1)	A(3)			VA(2)	VA(1)	VA(1)
Oscillatoria			VA(5)		VC(2)			VC(6)	A(5)		VC(4)				
Phormidium						VA(5)	VA(2)					C(5)			A(5)
Rivularia															VC(6)
Tolypothrix														A(6)	
Rhodophyta (red algae)															
Audouinella													VC(6)		

Table 4. Estimated relative abundance of algal cells and rank by volume ( ) of diatoms and the five most abundant non-diatom genera in periphyton samples collected from monitoring sites on the middle and lower Clark Fork and tributaries during August 2000. VA = very abundant, A = abundant, VC = very common, C = common.

taxa	stream/ station:	FTC 11.5	CFR 11.7	CFR 12	RKC 12.5	CFR 13	BFR 14	CFR 15.5	CFR 18	BRR 19	CFR 20	CFR 24	CFR 25	CFR 27
Chlorophyta (green algae)														
Ankistrodesmus										A(5)				
Chaetophora							A(5)							VC(5)
Cladophora		VC(3)	VC(4)	A(2)		VC(6)		VC(5)	VC(3)	C(4)	VC(4)	VC(1)	A(2)	VC(2)
Cosmarium				VC(6)				VC(6)	VC(6)					VC(3)
Mougeotia							A(3)							
Oedogonium			A(1)	C(5)				A(3)						
Pediastrum										VC(6)	VC(6)			
Scenedesmus					A(6)				VC(5)	A(3)	A(5)	A(4)	A(5)	A(6)
Spirogyra														VC(4)
Stigeoclonium			A(5)	VC(4)	A(3)	A(4)			VC(4)		A(2)			
Chrysophyta (golden algae)														
Diatoms (Bacillariophyceae)		A(4)	VA(3)	VA(1)	VA(1)	VA(2)	A(4)	VA(2)	VA(1)	VA(1)	VA(1)	VC(7)	VA(1)	VA(1)
Cyanophyta (blue-green algae)														
Chamaesiphon												VA(3)	A(6)	
Dichothrix							A(2)							
Nostoc		VA(1)	VA(2)		VC(5)	VA(3)		VA(1)						
Oscillatoria		VA(2)			VA(2)	VA(1)	VA(1)					A(2)		
Phormidium		VA(5)	VC(6)	VA(3)	VA(4)	VA(5)		VA(4)	VA(2)		VA(3)		VA(4)	
Rivularia							A(6)							
Phaeophyta (brown algae)														
Heribaudiella										A(2)				
Rhodophyta (red algae)														
Asterocystis												VC(5)	A(3)	
Audouinella		VC(6)												

Table 5. Criteria for rating levels of biological integrity, environmental impairment or natural stress, and aquatic life use support in wadable **mountain streams** of Montana using selected metrics for benthic diatom associations (Bahls 1993). The lowest rating for any one metric is the overall rating for the study site. Beneficial use support ratings and Diversity Index criteria reflect changes to the original criteria that are as yet unpublished (Dr. Loren Bahls, pers. com.).

Biological Integrity/ Impairment or Natural Stress/ Use Support	Diversity Index[1] (Shannon)	Pollution Index[2]	Siltation Index[3]	Disturbance Index[4]	Number of Species Counted	Percent Dominant Species	Similarity Index[5]	Bioassessment Protocol I Score
Excellent/None/ Full Support	>2.99	>2.50	<20.0	<25.0	>29	<25.0	>59.9	4
Good/Minor/ Full Support	2.00-2.99	2.01-2.50	20.0-39.9	25.0-49.9	20-29	25.0-49.9	40.0-59.9	3
Fair/Moderate/ Partial Support	1.00-1.99	1.50-2.00	40.0-59.9	50.0-74.9	10-19	50.0-74.9	20.0-39.9	2
Poor/Severe/ Nonsupport	<1.00	<1.50	>59.9	>74.9	<10	>74.9	<20.0	1

[1]Shannon diversity and species richness may increase somewhat in naturally nutrient-poor waters in response to slight to moderate increases in nutrients or sediment.

[2]This is a composite numeric expression of the pollution tolerances assigned by Lange-Bertalot (1979) to the common diatom species; responds to **organic** pollution only.

[3]Computed as the sum of the percent abundances of all species in the genera *Navicula, Nitzschia* and *Surirella*. These are common genera of predominantly motile taxa that are able to maintain their positions on the substrate surface in depositional environments.

[4]Computed as the percent abundance of *Achnanthes minutissima*. This attached taxon typically dominates early successional stages of benthic diatom associations and resists chemical, physical and biological disturbances in the form of metal toxicity, substrate scour by high flows and fast currents, and grazing by macroinvertebrates (Barbour *et al.* 1997).

[5]The Similarity Index or Percent Community Similarity (Whittaker 1952) may be used to gauge the relative amount of impairment or recovery that occurs between adjacent study sites: >59.9% = very similar floras, no change; 40.0-59.9% = somewhat similar floras, minor change; 20.0-39.9% = somewhat dissimilar floras, moderate change; <20.0% = very dissimilar floras, major change.

Table 6. Percent abundance of major diatom species[1] and values of selected diatom association metrics for periphyton samples collected from the upper Clark Fork and tributaries during August 2000. Underlined values indicate full support of aquatic life uses with minor impairment; **bold values** indicate partial support of aquatic life uses with moderate impairment; **underlined and bold values** indicate nonsupport of aquatic life uses with severe impairment based on criteria for wadable mountain streams in Table 5 (Bahls 1993). Values for Similarity Index (Whittaker 1952) are between adjacent mainstem stations. Arrows (> <) denote comparisons of sites above and below intervening tributaries.

Species/Metric (Pollution Tolerance)	Stream/ Station:	BTC SF-1	SBC 00	SBC 01	SBC 2.5	MWB MW2	SBC 4.5	WSC 06	CFR 07	CFR 08	CFR 8.5	CFR 09	CFR 10	LBR 10.2	CFR 11
Achnanthes lanceolata (2)		14.63													
Achnanthes minutissima (3)											26.76	17.64			
Cocconeis pediculus (3)						15.79									
Cocconeis placentula (3)														17.06	
Cyclotella meneghiniana (2)			26.74			11.12								11.73	
Cymbella silesica (3)			21.94					10.33							
Epithemia sorex (3)							14.25		10.87	17.92			25.06	10.43	44.92
Fragilaria construens (3)		16.17												14.22	
Gomphonema minutum (3)						18.66									
Gomphonema parvulum (1)				18.75											
Navicula cryptotenella (2)													18.55		15.29
Navicula minima (1)				13.70	46.70										
Nitzschia dissipata (3)								11.54							
Nitzschia fonticola (3)							16.65							12.56	
Nitzschia palea (1)			14.39	42.07	21.61										
Nitzschia paleacea (2)							16.53								
Synedra ulna (2)				17.07							19.01	42.94			
Number of Species Counted		45	26	**19**	**16**	36	33	44	52	50	34	33	40	35	34
Percent Dominant Species		16.17	26.74	42.07	46.70	18.66	16.65	11.54	10.87	17.92	26.76	42.94	25.06	17.06	44.92
Shannon Species Diversity		4.43	3.25	2.40	2.45	3.90	3.84	4.52	4.88	4.62	3.72	2.99	4.03	3.96	3.20
Pollution Index		2.44	2.12	**1.24**	**1.28**	2.63	2.49	2.62	2.53	2.47	2.39	2.27	2.54	2.73	2.73
Siltation Index		38.05	23.98	**59.74**	**81.89**	2.99	**49.10**	**42.89**	**43.12**	**42.77**	25.79	20.56	39.64	26.18	33.33
Disturbance Index		4.88	0.84	0.48	9.48	5.26	0.96	6.80	3.26	1.43	26.76	17.64	3.73	2.13	0.60
Percent Epithemiaceae						2.27	14.25		10.87	17.92	0.48		25.06	10.43	0.60
Similarity Index			**31.28**	**32.39**	42.88 >	**2.64**	< >	57.46	<	62.37	**39.54**	65.42	**30.18** >	68.47	< >

[1] A major diatom species is here defined as one that accounts for 10.0 percent or more of the diatom cells counted at one or more stations.

Table 7. Percent abundance of major diatom species[1] and values of selected diatom association metrics for periphyton samples collected from the middle and lower Clark Fork and tributaries during August 2000. Underlined values indicate full support of aquatic life uses with minor impairment; **bold values** indicate partial support of aquatic life uses with moderate impairment; **underlined and bold values** indicate nonsupport of aquatic life uses with severe impairment based on criteria for wadable mountain streams in Table 5 (Bahls 1993). Values for Similarity Index (Whittaker 1952) are between adjacent mainstem stations. Arrows (> <) denote comparisons of sites above and below intervening tributaries.

Species/Metric (Pollution Tolerance)	Stream/ Station:	**FTC 11.5**	**CFR 11.7**	**CFR 12**	**RKC 12.5**	**CFR 13**	**BFR 14**	**CFR 15.5**	**CFR 18**	**BRR 19**	**CFR 20**	**CFR 24**	**CFR 25**	**CFR 27**
Achnanthes biasolettiana (3)														11.71
Achnanthes minutissima (3)							18.49	15.71		26.44				15.61
Cocconeis pediculus (3)												10.77		
Cocconeis placentula (3)												13.73	11.69	
Cymbella affinis (3)							23.53		20.52	14.00	22.24	12.66	11.33	10.37
Cymbella microcephala (2)														19.39
Diatoma moniliformis (2)						12.03								
Diatoma vulgaris (3)			13.34	14.76										
Epithemia sorex (3)			23.44	37.54										
Navicula capitatoradiata (2)									12.26		15.07			
Nitzschia fonticola (3)					16.69									
Nitzschia paleacea (2)					14.29	17.74								
Synedra ulna (2)			19.59							13.88				12.56
Species Richness		43	33	34	39	34	43	46	39	30	35	40	41	30
Percent Dominant Species		none[1]	23.44	37.54	16.69	17.74	23.53	15.71	20.52	26.44	22.24	13.73	11.69	19.39
Shannon Species Diversity		4.65	3.58	3.35	4.18	4.17	3.95	4.64	4.18	3.62	3.97	4.25	4.48	3.65
Pollution Index		2.51	2.65	2.68	2.69	2.41	2.69	2.58	2.58	2.76	2.59	2.75	2.72	2.51
Siltation Index		**42.77**	25.72	27.15	**40.34**	**46.05**	8.04	**40.77**	**44.46**	6.34	**40.10**	17.04	20.34	5.37
Disturbance Index		1.42	0.24	0.24	6.24	2.31	18.49	15.71	3.54	26.44	8.75	6.86	7.80	15.61
Percent Epithemiaceae		8.89	23.44	37.54	10.08	6.68	0.96	3.36	1.30	0.24	0.97	1.66	8.53	
Similarity Index		53.63	< 73.51	>	**39.67**	< >	53.93	< 57.95	>	76.58	<	60.07	76.38	**39.73**

[1] A major diatom species is here defined as one that accounts for 10.0 percent or more of the diatom cells counted at one or more stations.

Table 8. Ratings for biological integrity, aquatic life impairment and beneficial use support at monitoring stations on the upper Clark Fork and tributaries during August 2000, using criteria in Table 5 and diatom association metrics in Table 6.

Parameter	Stream/ Station:	BTC SF-1	SBC 00	SBC 01	SBC 2.5	MWB MW2	SBC 4.5	WSC 06	CFR 07	CFR 08	CFR 8.5	CFR 09	CFR 10	LBR 10.2	CFR 11
Protocol I Low Score		3	3	1	1	4	2	2	2	2	3	3	3	3	3
Biological Integrity		good	good	poor	poor	excellent	fair	fair	fair	fair	good	good	good	good	good
Aquatic Life Impairment		minor	minor	severe	severe	none	moderate	moderate	moderate	moderate	minor	minor	minor	minor	minor
Beneficial Use Support		full	full	non-	non-	full	partial	partial	partial	partial	full	full	full	full	full
Limiting Metric(s)		pollution siltation	pollution siltation	pollution	pollution siltation	none	siltation	siltation	siltation	siltation	pollution siltation	diversity pollution siltation	siltation	siltation	siltation

Table 9. Ratings for biological integrity, aquatic life impairment and beneficial use support at monitoring stations on the middle and lower Clark Fork and tributaries during August 2000, using criteria in Table 5 and diatom association metrics in Table 7.

Parameter	Stream/ Station:	FTC 11.5	CFR 11.7	CFR 12	RKC 12.5	CFR 13	BFR 14	CFR 15.5	CFR 18	BRR 19	CFR 20	CFR 24	CFR 25	CFR 27
Protocol I Score		2	3	3	2	2	4	2	2	4	2	4	3	4
Biological Integrity		fair	good	good	fair	fair	excellent	fair	fair	excellent	fair	excellent	good	excellent
Aquatic Life Impairment		moderate	minor	minor	moderate	moderate	none	moderate	moderate	none	moderate	none	minor	none
Beneficial Use Support		partial	full	full	partial	partial	full	partial	partial	full	partial	full	full	full
Limiting Metric(s)		siltation	siltation	siltation	siltation	siltation	none	siltation	siltation	none	siltation	none	siltation	none

Figure 3. Number of genera of dominant non-diatom algae from the Clark Fork and tributaries during August 2000. Station 22 not sampled.

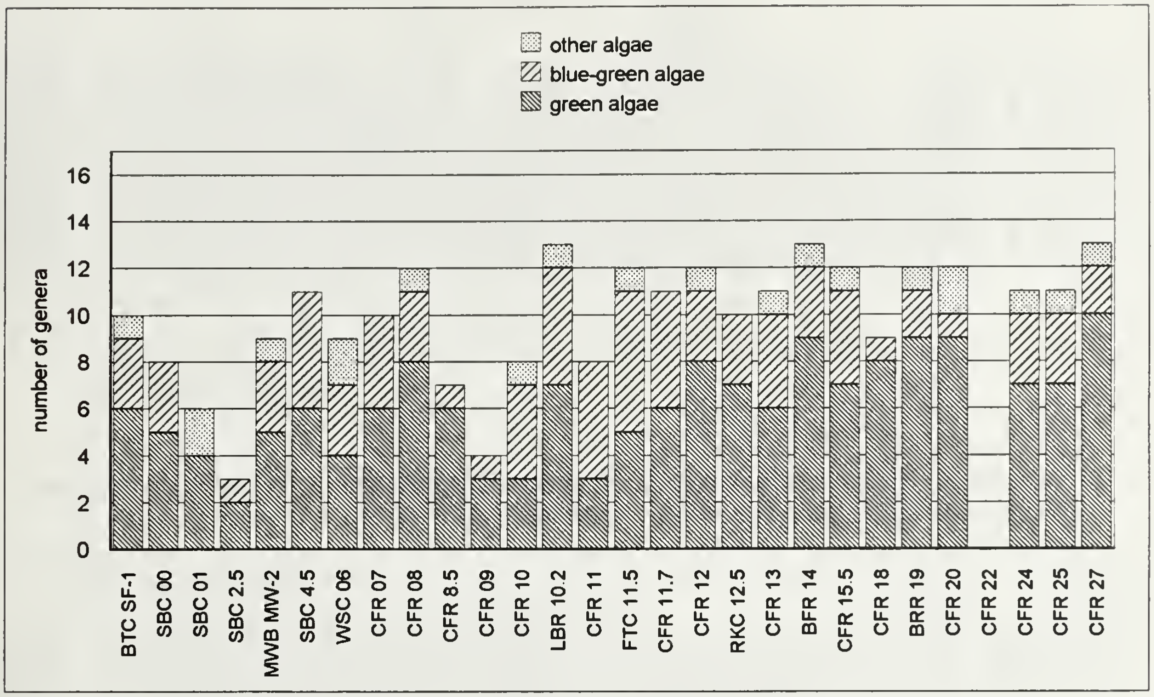


Figure 4. Percent community similarity of diatom floras between adjacent mainstem Silver Bow Creek and Clark Fork stations, August 2000.

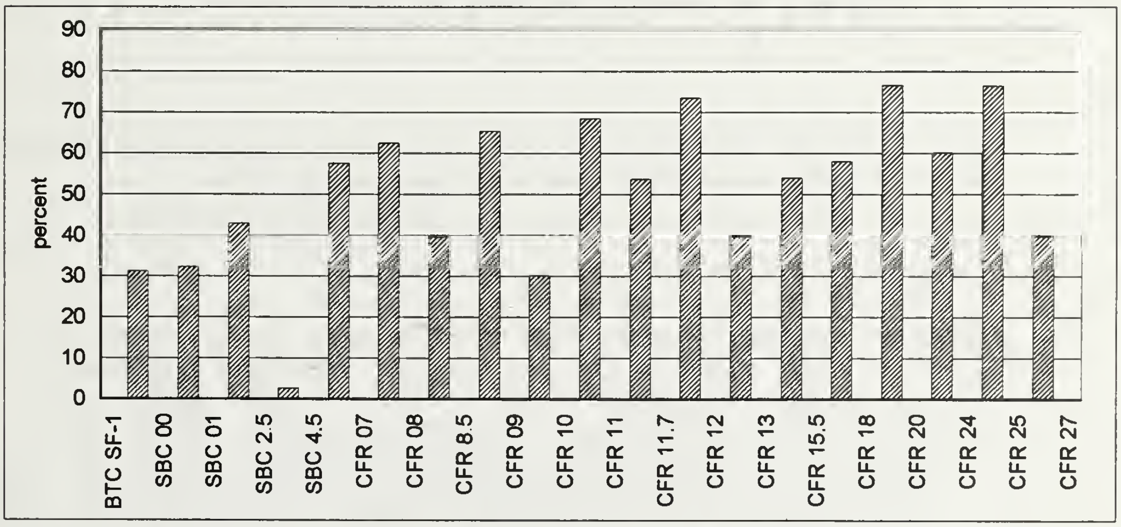


Figure 5. Shannon diversity index values for diatom associations from the Clark Fork and tributaries during August 2000. Station 22 not sampled.

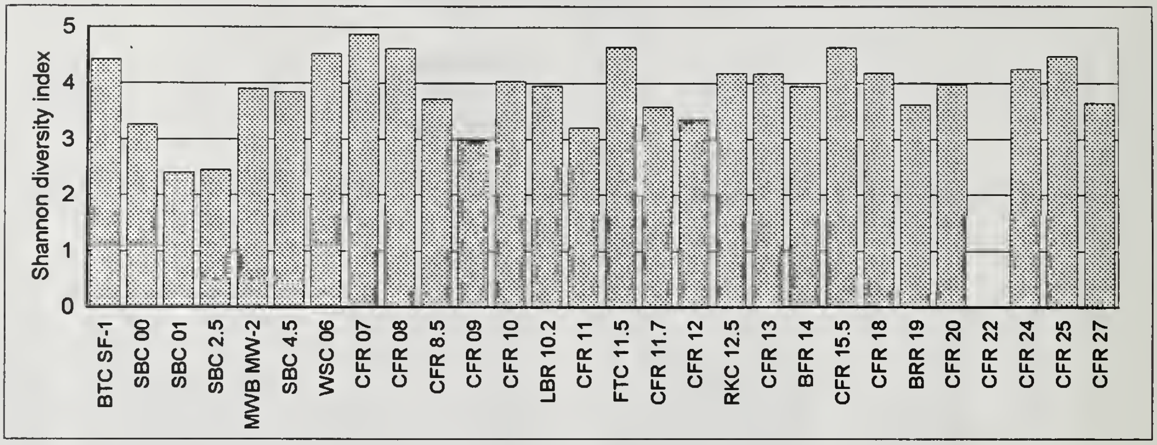


Figure 6. Pollution index values for diatom associations from the Clark Fork and tributaries during August 2000. Station 22 not sampled.

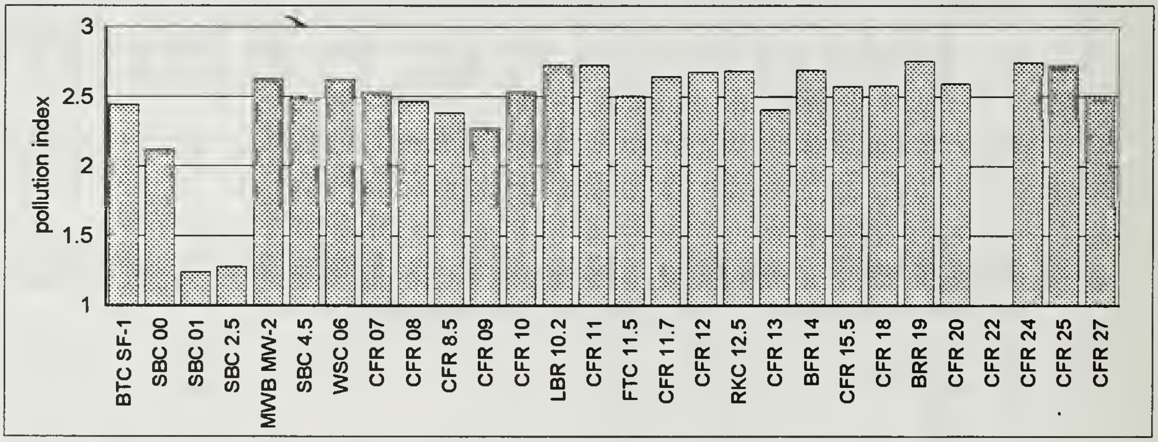


Figure 7. Siltation index values for diatom associations from the Clark Fork and tributaries during August 2000. Station 22 not sampled.

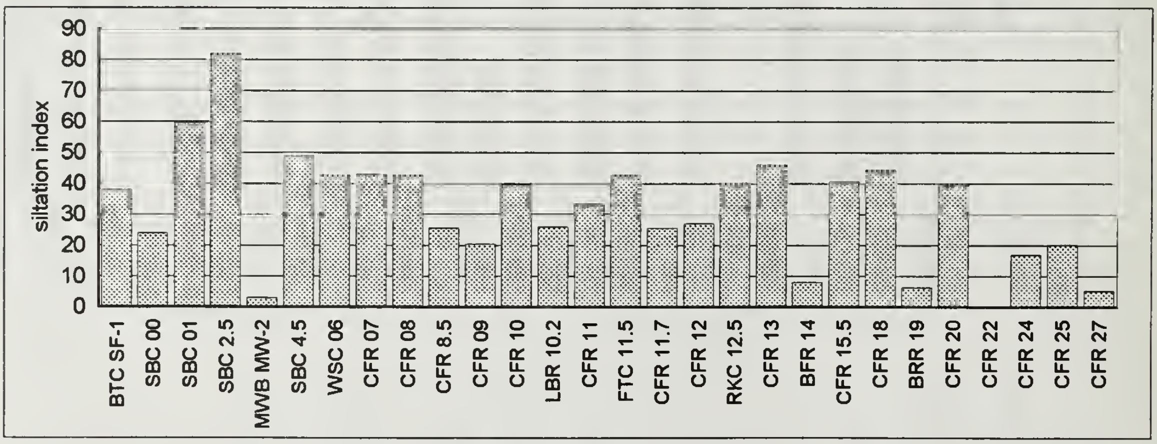


Figure 8. Pollution index values for Blacktail Creek above Grove Gulch (station SF-1), 1993-2000.

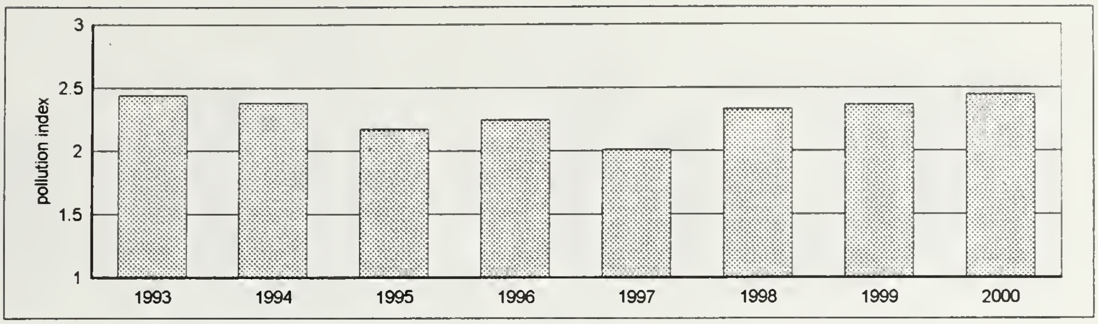


Figure 9. Pollution index values for Silver Bow Creek above the Butte WWTP (station 00), 1989-2000.

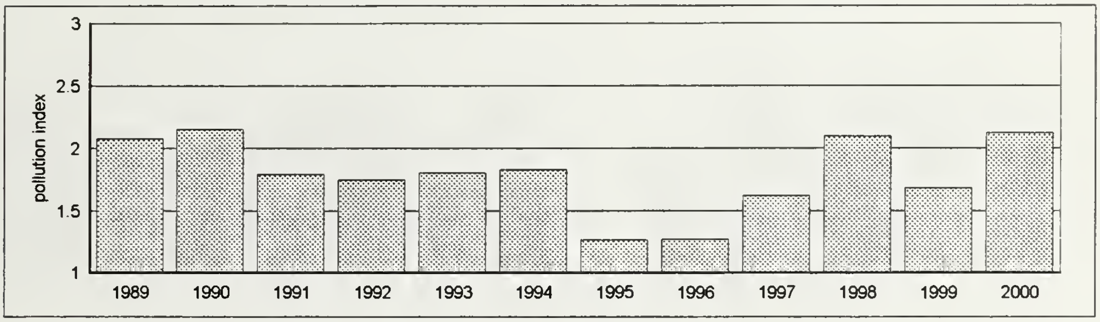


Figure 10. Pollution index values for Silver Bow Creek below the Colorado Tailings (station 01), 1989-2000.

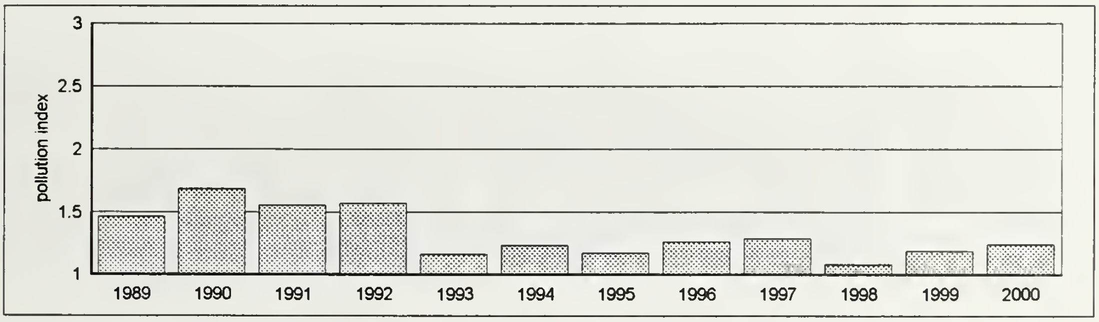


Figure 11. Pollution index values for Silver Bow Creek at Opportunity (station 2.5), 1989-2000. (station 03, 1989-91; not sampled in 1992).

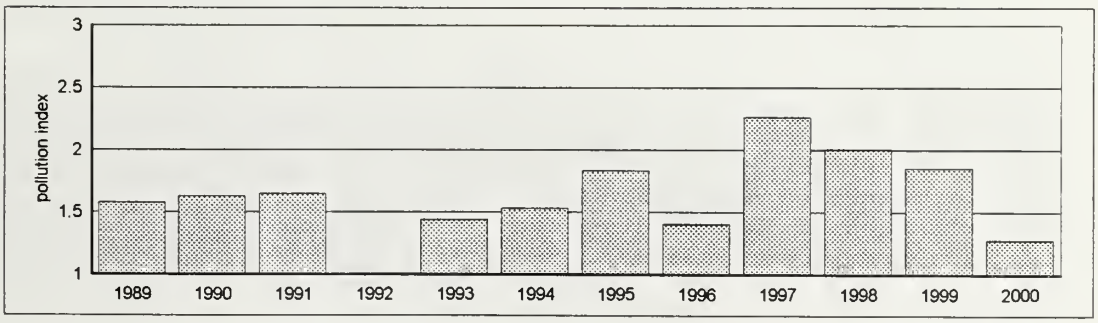


Figure 12. Pollution index values for Mill Creek-Willow Creek Bypass near mouth (station MW2), 1989-2000. (station 05, 1989-92; not sampled in 1993-98).

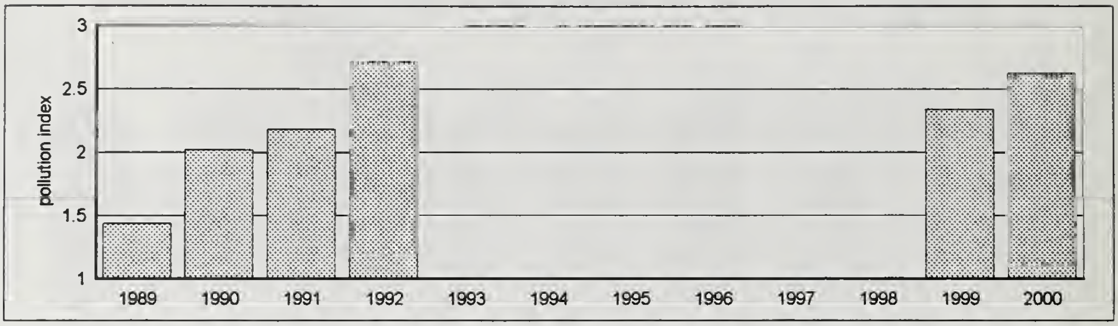


Figure 13. Pollution index values for Silver Bow Creek below Warms Springs Ponds (station 4.5), 1989-2000. (station 04, 1989-91; not sampled in 1992).

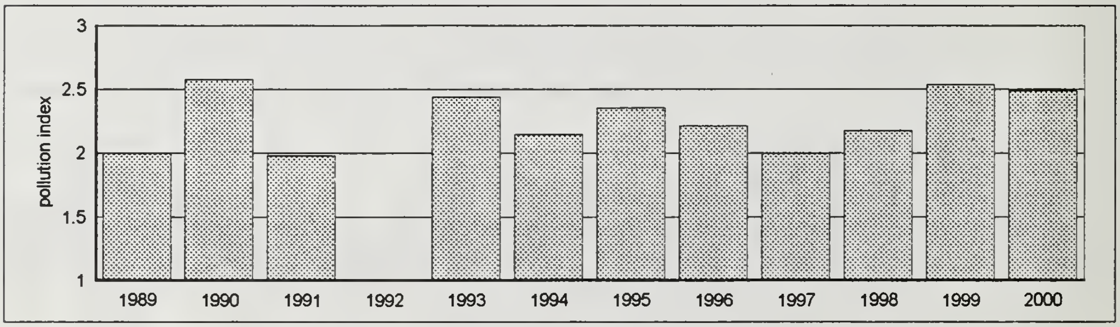


Figure 14. Pollution index values for Warm Springs Creek near mouth (station 06), 1989-2000.

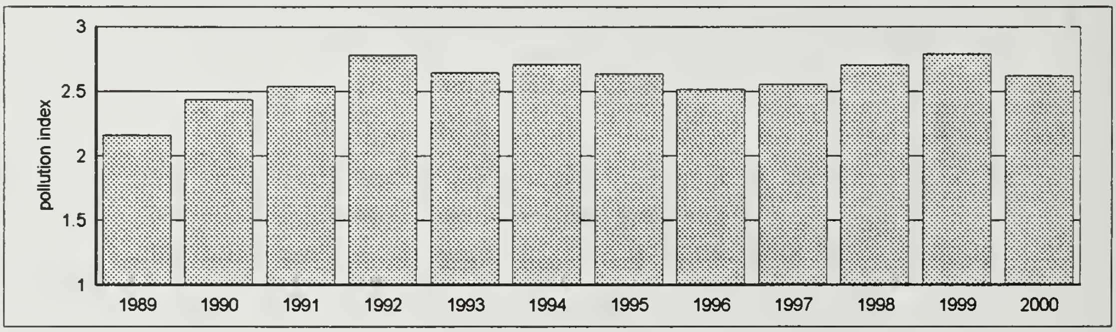


Figure 15. Pollution index values for Clark Fork below Warm Springs Creek (station 07), 1989-2000.

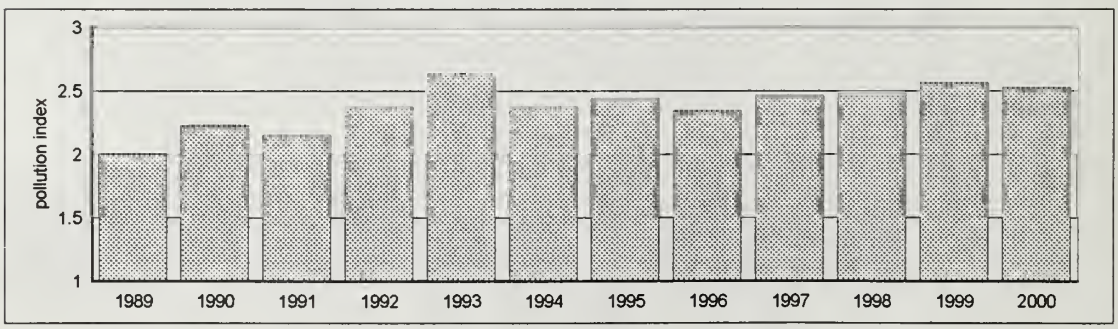


Figure 16. Pollution index values for Clark Fork at Dempsey (station 08), 1989-2000; (not sampled in 1993-1997).

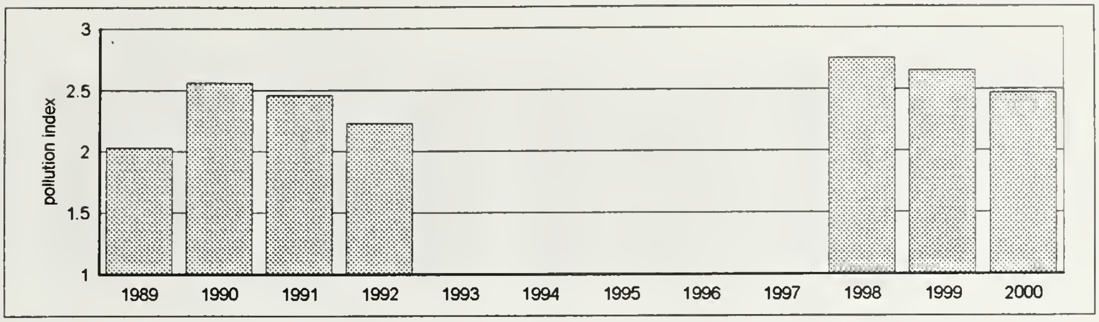


Figure 17. Pollution index values for Clark Fork at Sager Lane (station 8.5), 1989-2000; (not sampled 1989, 1993-1997).

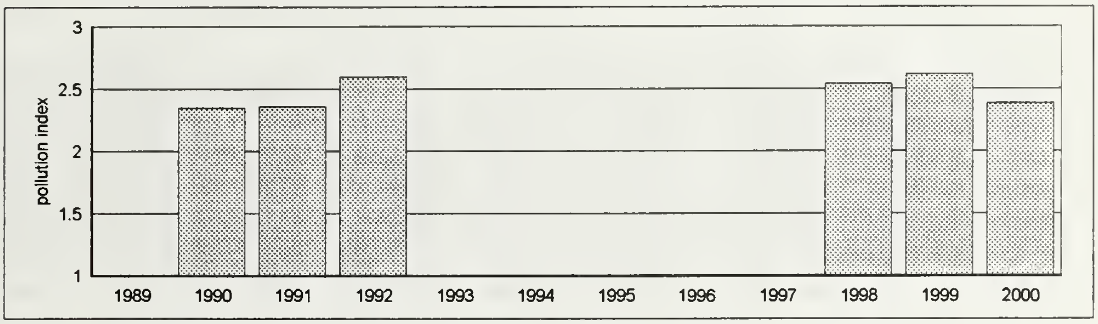


Figure 18. Pollution index values for Clark Fork at Deer Lodge (station 09), 1989-2000.

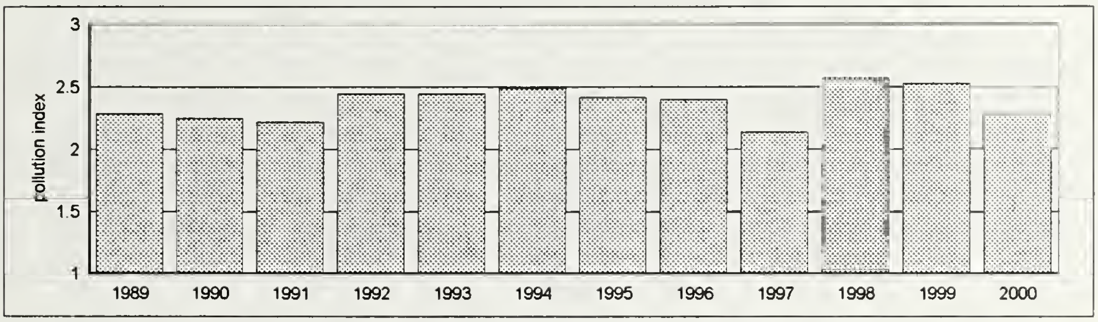


Figure 19. Pollution index values for Clark Fork above the Little Blackfoot River (station 10), 1989-2000.

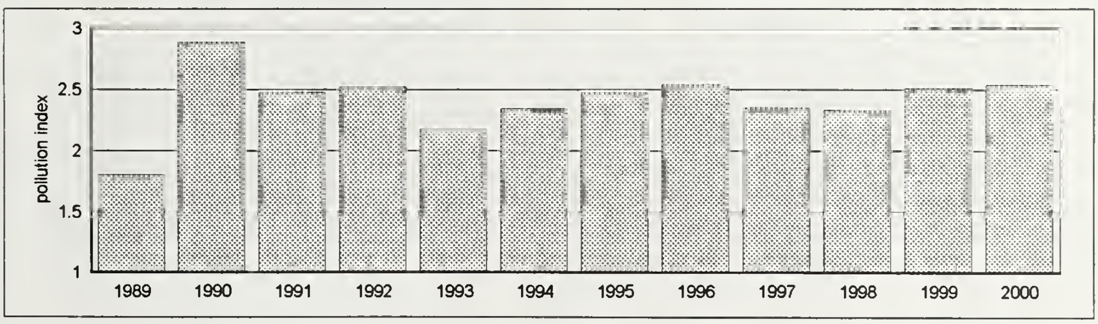


Figure 20. Pollution index values for Little Blackfoot River near mouth (station 10.2), 1993-2000.

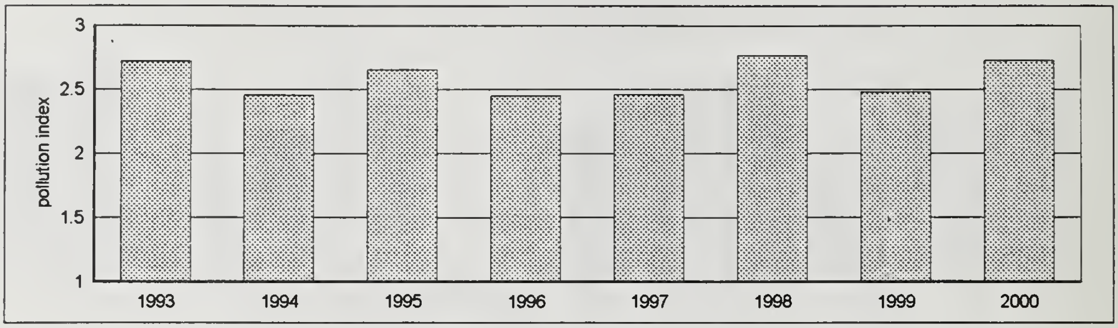


Figure 21. Pollution index values for Clark Fork at Gold Creek Bridge (station 11), 1989-2000.

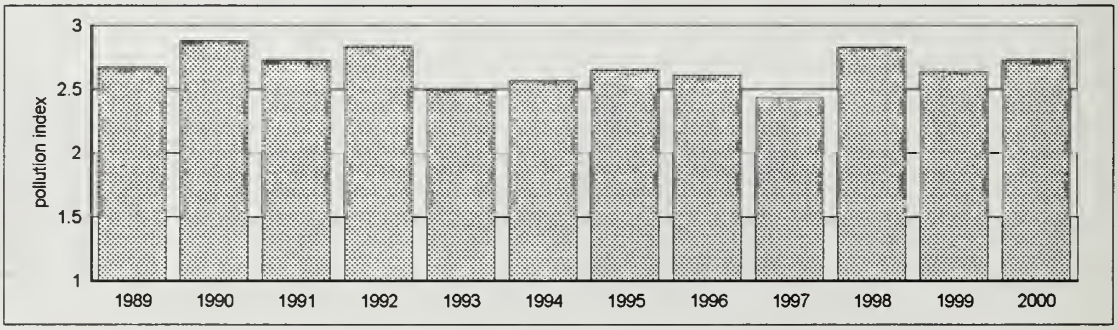


Figure 22. Pollution index values for Flint Creek at new Chicago (station 11.5), 1993-2000.

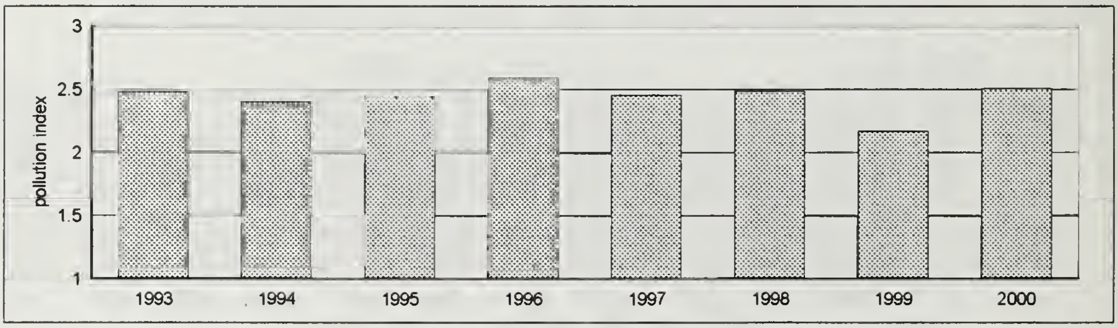


Figure 23. Pollution index values for Clark Fork at Bearmouth (station 11.7), 1993-2000.

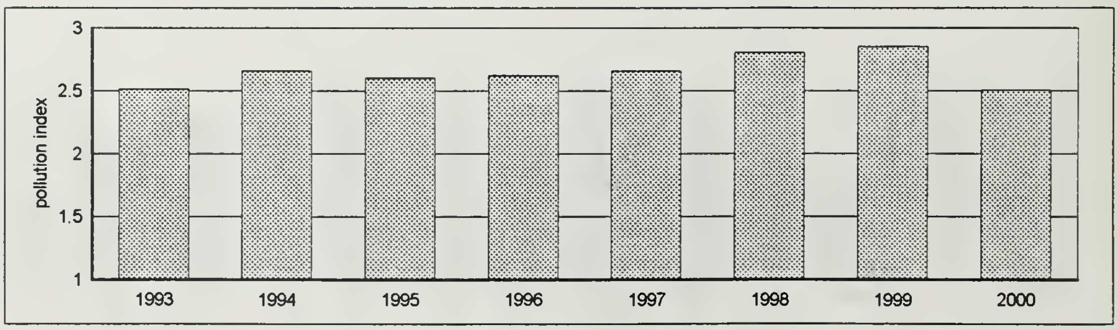


Figure 24. Pollution index values for Clark Fork at Bonita (station 12), 1989-2000.

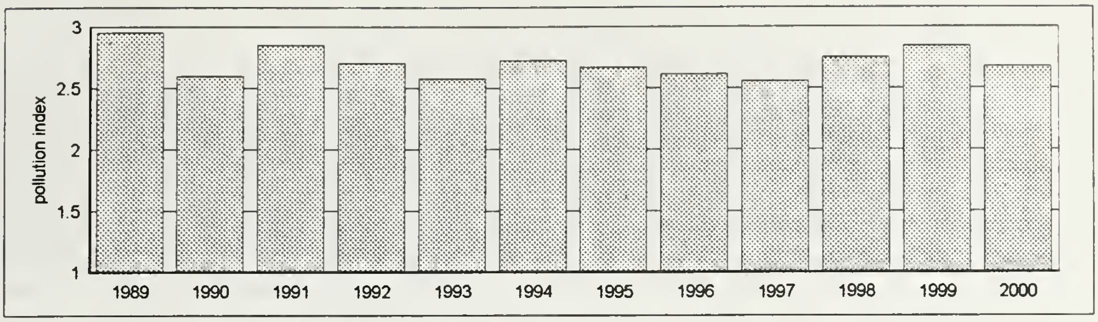


Figure 25. Pollution index values for Rock Creek near Clinton (station 12.5), 1993-2000.

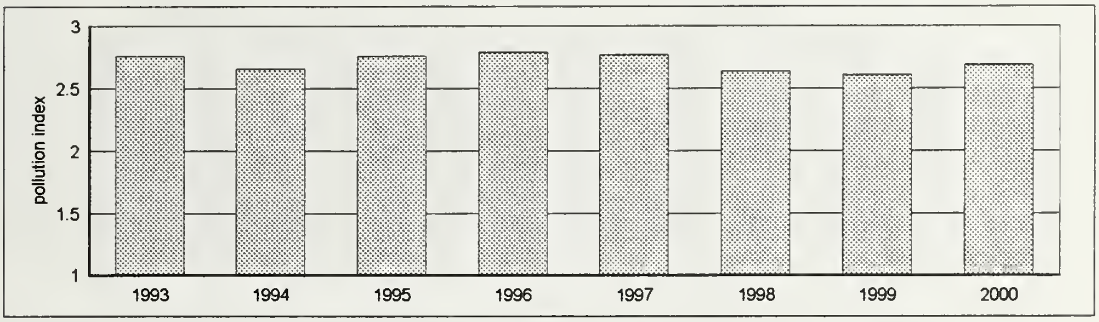


Figure 26. Pollution index values for Clark Fork at Turah (station 13), 1989-2000.

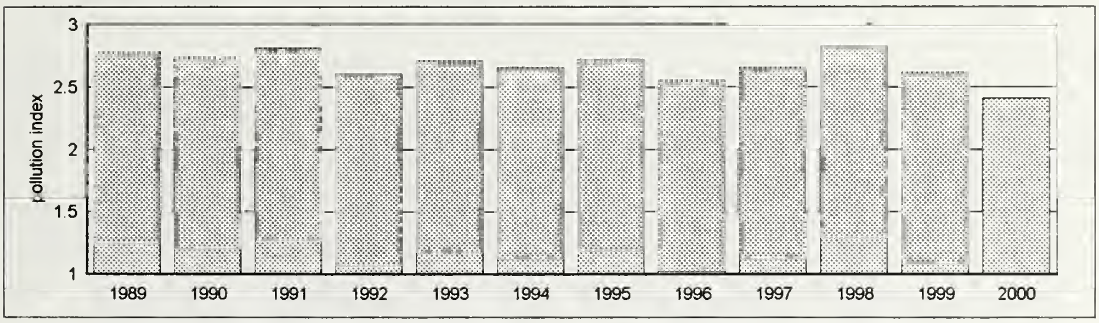


Figure 27. Pollution index values for Blackfoot River near mouth (station 14), 1989-2000.

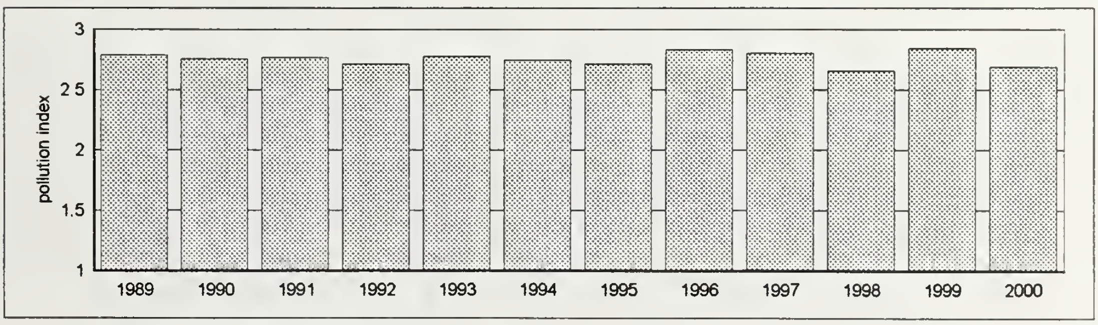


Figure 28. Pollution index values for Clark Fork above Missoula (station 15.5), 1989-2000.

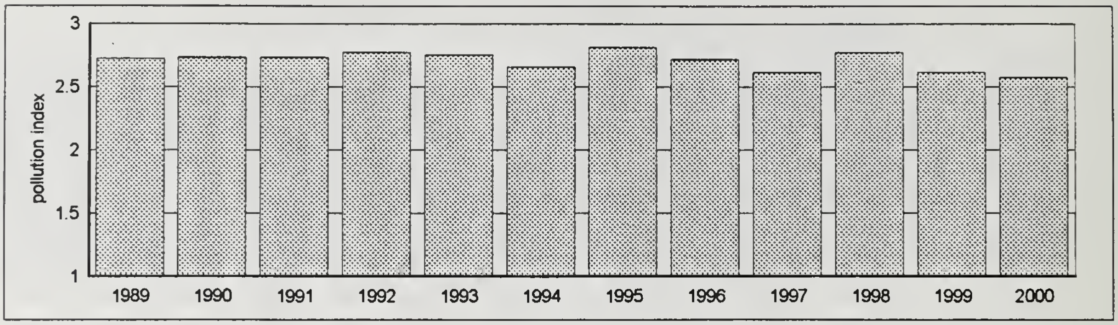


Figure 29. Pollution index values for Clark Fork at Shuffields (station 18), 1989-2000.

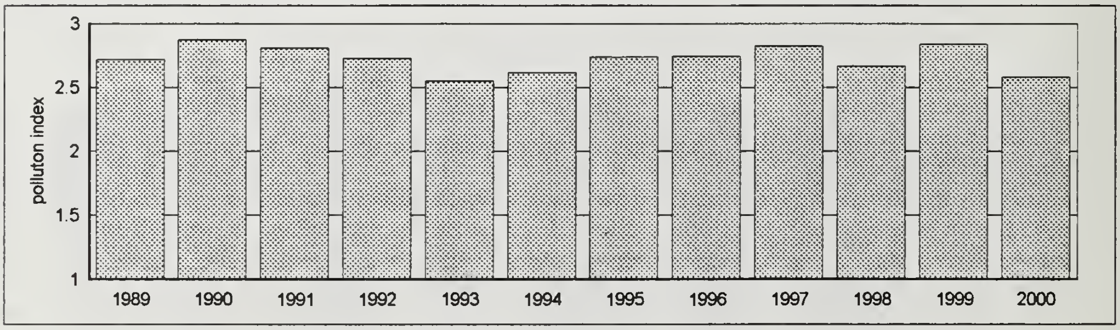


Figure 30. Pollution index values for Bitterroot River near mouth (station 19), 1989-2000.

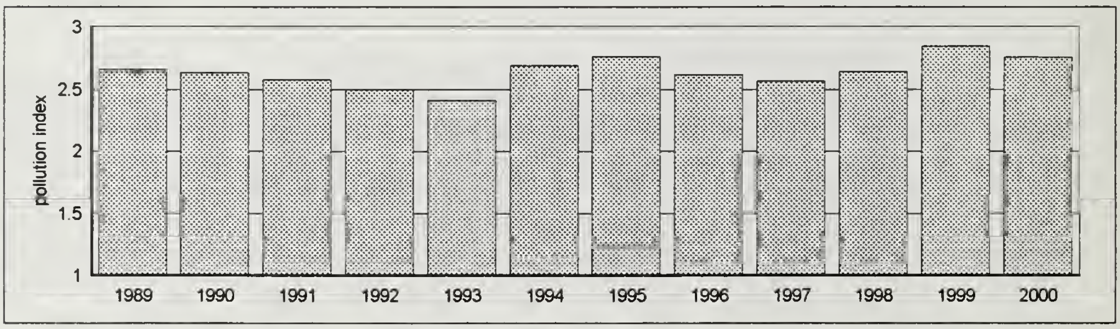


Figure 31. Pollution index values for Clark Fork at Harper Bridge (station 20), 1989-2000.

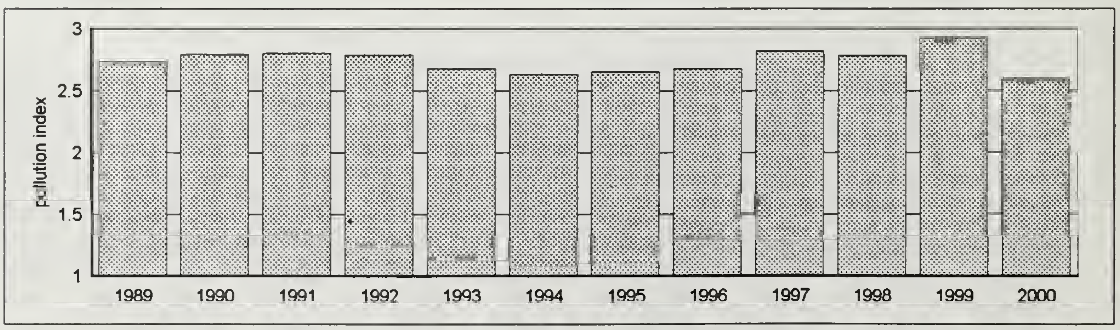


Figure 32. Pollution index values for Clark Fork at Huson (station 22), 1989-2000 (not sampled in 2000).

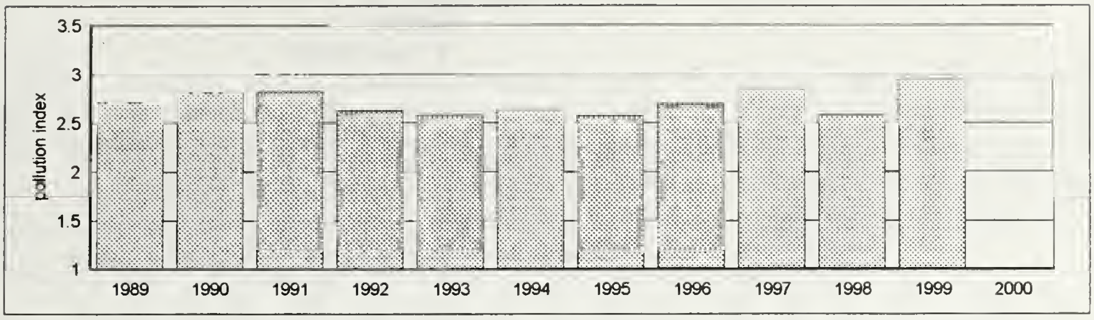


Figure 33. Pollution index values for Clark Fork near Superior (station 24), 1989-2000.

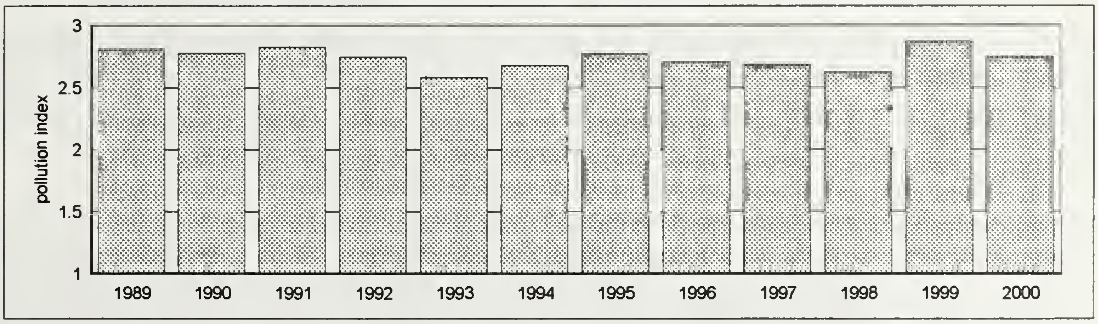


Figure 34. Pollution index values for Clark Fork above Flathead River (station 25), 1989-2000.

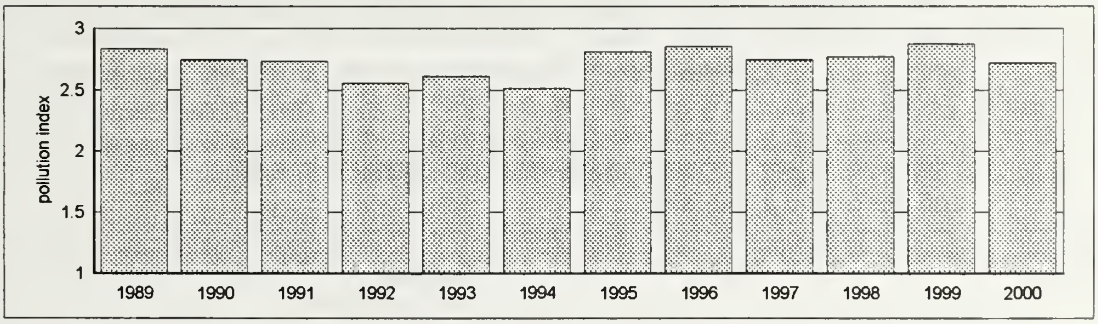


Figure 35. Pollution index values for Clark Fork above Thompson Falls Reservoir (station 27), 1989-2000.

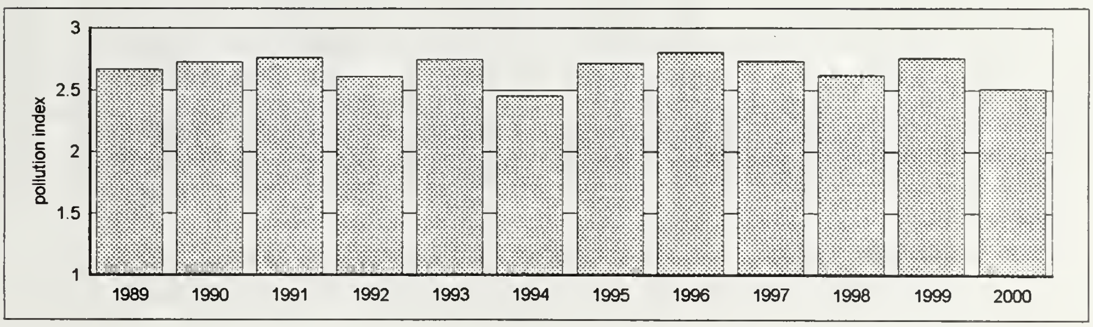
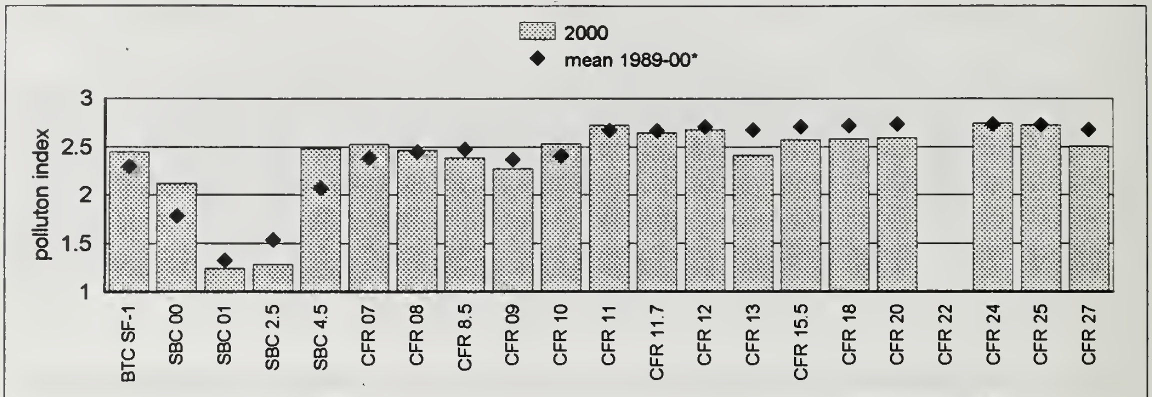
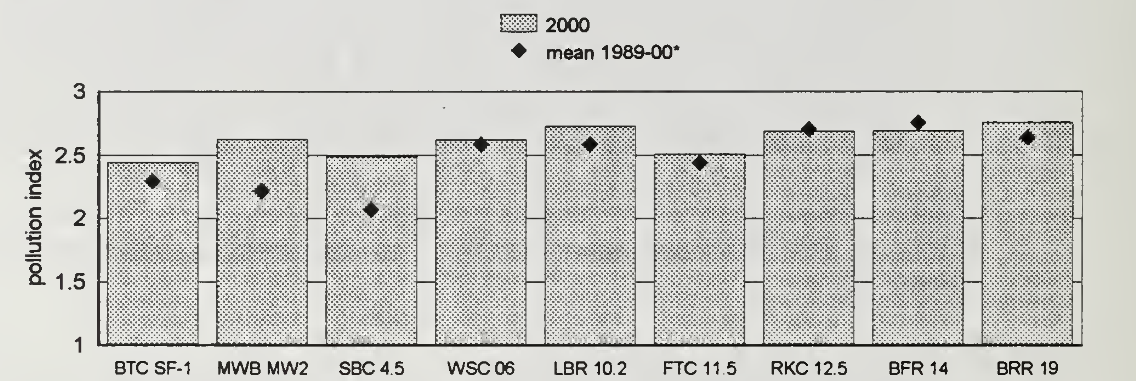


Figure 36. Pollution index values for 19 mainstem stations during August 2000, and long-term mean values for the period 1989-2000*.



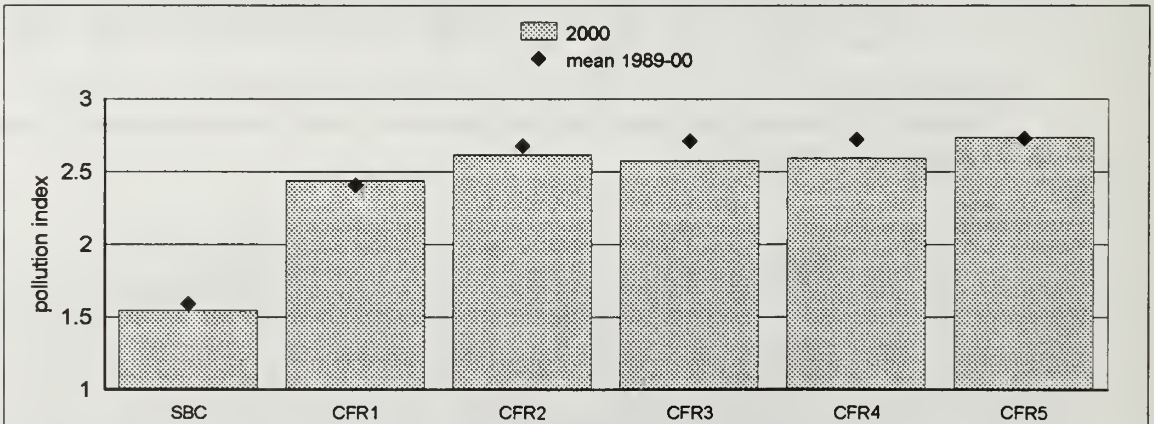
*SF-1 and 11.7: mean for 1993-00; 08: mean 1989-92, 1998-00; 8.5: mean 1990-92, 1998-00; 22 not sampled in 2000

Figure 37. Pollution index values for selected Clark Fork tributaries during August 2000, and long-term mean values for the period 1989-2000*.



*BTC SF-1, LBR 10.2, FTC 11.5, and RKC 12.5: mean 1993-00; MWB MW2: mean 1989-92, 1999-00

Figure 38. Mean pollution index values in Clark Fork reaches* during August 2000 and the period 1989-2000.



*SBC: stations 00, 01 and 2.5; CFR1: stations 07, 08, 8.5, 09 and 10; CFR2: stations 11, 11.7, 12 and 13; CFR3: stations 15.5 and 18; CFR4: stations 20 and 22, 20 only in 2000; CFR5: stations 24 and 25.

CONCLUSIONS

1. Metrics for both non-diatom and diatom algae associations indicated minor impairment of water quality and biological integrity in the headwaters Silver Bow Creek upstream of the Butte Metro wastewater discharge in 2000. Silver Bow Creek downstream Butte, but above the Warm Springs Ponds, was severely impaired based on the algal metrics. Downstream of the Warm Springs Ponds, the general trend was for improved water quality and biological integrity in the Clark Fork mainstem with increased distance from the headwaters.

2. Moderate improvement in biological integrity and beneficial use support was evident in the reach of Silver Bow Creek above the Butte Metro wastewater discharge, which was re-constructed in 1998 as part of the Super Fund Program's Colorado Tailings clean-up and remediation.

3. Silver Bow Creek stations between Butte and the Warm Springs Ponds continued to be the most heavily impaired, with poor biological integrity within this reach in 2000. Beneficial uses of aquatic life were not supported due to excessive concentrations of biogenic wastes, sediment and toxic heavy metals pollution.

4. Biological integrity in Silver Bow Creek below the Warm Springs ponds was rated only fair, with moderate impairment of aquatic life indicated in August 2000 due to siltation. The absence of streamflow sufficiently high to flush accumulated sediment from the channel is a possible reason for the moderate impairment rating. Other metrics did not indicate more than minor impairment in Silver Bow Creek below the ponds.

5. The Mill Creek-Willow Creek Bypass had excellent biological integrity with unimpaired aquatic life, indicating very good water quality several years after tailings removal and channel reconstruction under the Super Fund program. Indications are that historic bouts of heavy metals pollution to the upper Clark Fork from the bypass channel have been mitigated, and that this significant source of clean water will greatly benefit the biota in the upper Clark Fork.

6. Warm Springs Creek was rated moderately-impaired, with only partial support of aquatic life during August 2000 due to an elevated siltation index, although other algal metrics did not indicate impairment.

7. The biota in the upper Clark Fork between Warm Springs Creek and the Little Blackfoot River saw minor to moderate impairment during August 2000. This was due primarily to the continued impacts of drought and low streamflows, including inadequate flushing of accumulated sediment, as well as stress from elevated nutrient and metals concentrations and water temperature. Relatively low streamflows during 1999 and 2000 may also have had a positive effect on biological integrity between Deer Lodge and the Little Blackfoot River by reducing bank erosion and sediment transport in this reach with generally poor streambank conditions. Beneficial aquatic life uses were partially to fully supported.

8. Biological integrity in 2000 at Clark Fork stations between the Little Blackfoot River and Missoula saw only minor impairment above Rock Creek, but moderate impairment below both Rock Creek and the Blackfoot River, due to sediment impacts. Aquatic life was moderately impaired at the two stations downstream of the Missoula wastewater discharge (and above and below the Bitterroot River). The two stations between Superior and the Flathead River fully supported beneficial aquatic life uses.

9. The Little Blackfoot River had minor aquatic life impairment in 2000, while Flint Creek was moderately impaired due to probable sediment impacts. Rock Creek also was rated as moderately impaired by a narrow margin in 2000 due to elevated sediment, although most algal metrics indicated an unimpaired biota. The Blackfoot River and Bitterroot River were unimpaired, with excellent biointegrity and full support of beneficial aquatic life uses during August 2000. The Blackfoot River and the Bitterroot River, as well as Rock Creek, continue to be major contributors of high-quality water to the Clark Fork.

10. The Missoula WWTP discharge did not appear to have a significant additional impact on the Clark Fork, as evidenced by similar biological integrity and aquatic life impairment at the stations upstream and downstream of the outfall. Any impacts on the Clark Fork biota caused by seepage from wastewater ponds at the Smurfit-Stone Container Corporation Frenchtown Mill could not be assessed in 2000, as the Clark Fork at Huson could not be sampled. However, in 1999 biological integrity decreased slightly in the Clark Fork from Harper Bridge to Huson, indicating minor impairment of aquatic life through this reach.

11. Compared to long-term trends, biological integrity at Silver Bow Creek upstream of the Butte wastewater discharge was above-average, while at sites downstream of Butte but upstream of the Warm Springs Ponds, biological integrity was somewhat less than average in 2000. At upper Clark Fork sites, beginning with Silver Bow Creek below the Warm Springs Ponds, biological integrity progressed from significantly better than average to slightly less than average downstream at Deer Lodge. Middle Clark Fork stations had near-average biological integrity downstream as far as Rock Creek. At lower Clark Fork sites from just above Missoula to just below the Bitterroot River, biological integrity was slightly less than the long-term average, while sites between Superior and the Flathead River were near-average during 2000. Biological integrity at Upper Clark Fork tributaries was considerably better than the long-term average, while tributaries to the middle and lower reaches of the Clark Fork were near-average in 2000.

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APPENDIX A

2000 Non-diatom algae

Estimated relative abundance and biovolume

Appendix A

Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, 2000.

R=rare; C=common; VC=very common; A=abundant; VA=very abundant

STREAM:	**BTC**	**SBC**	**SBC**	**SBC**	**MWB**	**SBC**	**WSC**
STATION NUMBER:	**SF-1**	**00**	**01**	**2.5**	**MW-2**	**4.5**	**06**
SAMPLE NUMBER:	1398H	0847O	0102U	0245J	1019I	1399H	1020O
2000 SAMPLING DATE:	8/19	8/19	8/18	8/18	8/18	8/18	8/18
Bacillariophyta (diatoms)							
All genera collectively	VA(2)	VA(3)	VA(1)	C(4)	VA(2)	VA(3)	VA(1)
Chlorophyta (green algae)							
Ankistrodesmus	C(10)	C(9)			VA(6)	VC(11)	
Cladophora		A(2)			VC(1)	VC(5)	C(5)
Closterium	C(5)				R	C(7)	C(8)
Coelastrum	R				R	R	R
Cosmarium	R	R	C(7)	C(3)	R		C(12)
Enteromorpha		VC(4)					
Gloeocystis	R	VA(1)	VA(3)		R	R	
Microspora	VA(3)						
Mougeotia							R
Oedogonium	VA(1)				VC(3)	VC(4)	A(2)
Pediastrum					R		R
Rhizoclonium	C(6)						
Scenedesmus	VC(8)	A(6)	VC(6)	VA(1)	VC(9)	VC(8)	C(13)
Staurastrum							C(7)
Stigeoclonium		R	A(4)		C(10)	A(6)	R
Ulothrix							C(10)
Chrysophyta (yellow-green algae)							
Tribonema			A(5)				
Vaucheria	VC(4)		A(2)				VC(4)
Cyanophyta (blue-green algae)							
Anabaena					R		
Calothrix					R		
Chamaesiphon		VC(8)			VA(7)	A(10)	
Merismopedia	C(11)						
Microcystis	C(9)					C(12)	
Nostoc					A(4)	VA(1)	A(3)
Oscillatoria	C(7)	A(5)	R	VC(2)	R	C(9)	VC(6)
Phormidium		C(7)			VA(5)	VA(2)	VC(9)
Rhodophyta (red algae)							
Asterocystis					VC(8)		
Audouinella							C(11)
Higher Aquatic Plants							
mosses	x						
macrophytes	x	x	x		x	x	
STATION NUMBER:	**SF-1**	**00**	**01**	**2.5**	**MW-2**	**4.5**	**06**
TOTAL NON-DIATOM GENERA:	13	10	7	3	17	13	16
# DOMINANT GENERA:	10	8	6	3	9	11	12
# GREEN:	6	5	4	2	5	6	7
# BLUE-GREEN:	3	3	0	1	3	5	3
# OTHER:	1	0	2	0	1	0	2
DOMINANT PHYLUM:	Chlor	Chlor	Chlor	Chlor	Chlor	Chlor	Chlor

Appendix A (continued)

Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, 2000.

R=rare; C=common; VC=very common; A=abundant; VA=very abundant

STREAM:	**CFR**	**CFR**	**CFR**	**CFR**	**CFR**	**LBR**	**CFR**
STATION NUMBER:	**07**	**08**	**8.5**	**09**	**10**	**10.2**	**11**
SAMPLE NUMBER:	0849R	1021J	1049F	0266Y	0850Q	1400H	0556Q
2000 SAMPLING DATE:	8/18	8/17	8/17	8/17	8/17	8/17	8/17
Bacillariophyta (diatoms)							
All genera collectively	VA(2)	VA(1)	VA(1)	VA(1)	VC(4)	VA(3)	A(4)
Chlorophyta (green algae)							
Ankistrodesmus	C(11)	C(12)	VC(7)	R	R	VC(14)	
Chaetophora						R	
Cladophora	VC(4)	C(5)	C(3)	VC(3)	VC(3)	C(8)	VC(2)
Closterium	C(6)	VC(7)	R	R	R	R	
Coelastrum						VC(9)	
Cosmarium	R	R	R	R		C(12)	
Gloeocystis		R	R	R		R	
Hormidium		R					
Mougeotia		VC(6)					
Oedogonium	A(3)	A(2)	C(5)	A(2)	A(1)	VC(5)	VC(3)
Pediastrum		C(9)	C(6)	R	R	R	
Scenedesmus	C(10)	C(11)	C(8)	R	C(8)	VC(13)	C(8)
Spirogyra						A(4)	
Staurastrum	R						
Stigeoclonium	C(7)	A(4)	A(2)	C(4)	R		R
Tetraspora			R				
Ulothrix						R	
Zygnema						R	
Chrysophyta (yellow-green algae)							
Tribonema						R	
Vaucheria					R	A(2)	R
Cyanophyta (blue-green algae)							
Anabaena	C(8)	R					
Calothrix					A(5)		C(7)
Chamaesiphon	R	R	R		C(9)	R	VC(9)
Lyngbya	R						
Microcystis	R	R					
Nostoc	VA(1)	A(3)			VA(2)	VA(1)	VA(1)
Oscillatoria	A(5)	VC(8)	VC(4)		R	C(10)	
Phormidium	C(9)	C(13)	R	C(5)	VC(7)	A(7)	A(5)
Rivularia						C(11)	VC(6)
Tolypothrix						A(6)	R
Rhodophyta (red algae)							
Asterocystis				R	R		R
Audouinella		C(10)			VC(6)	R	
Higher Aquatic Plants							
macrophytes	x		x			x	
mosses						x	x

STATION NUMBER:	**07**	**08**	**8.5**	**09**	**10**	**10.2**	**11**
TOTAL NON-DIATOM GENERA:	15	18	13	11	15	22	12
# DOMINANT GENERA:	10	12	7	4	8	13	8
# GREEN:	6	8	6	3	3	7	3
# BLUE-GREEN:	4	3	1	1	4	5	5
# OTHER:	0	1	0	0	1	1	0
DOMINANT PHYLUM:	Chlor	Chlor	Chlor	Chlor	Cyan	Chlor/Cyan	Cyan

Appendix A (continued)
Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, 2000.
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

STREAM:	**FTC**	**CFR**	**CFR**	**RKC**	**CFR**	**BFR**	**CFR**
STATION NUMBER:	**11.5**	**11.7**	**12**	**12.5**	**13**	**14**	**15.5**
SAMPLE NUMBER:	1401H	0652I	0557Q	1402H	0558W	0752U	0897R
2000 SAMPLING DATE:	8/16	8/16	8/16	8/16	8/16	8/15	8/14
Bacillariophyta (diatoms)							
All genera collectively	A(4)	VA(3)	VA(1)	VA(1)	VA(2)	A(4)	VA(2)
Chlorophyta (green algae)							
Ankistrodesmus	C(13)	VC(8)	C(13)	A(7)	VC(10)	C(14)	C(12)
Chaetophora				C(8)		A(5)	
Cladophora	VC(3)	VC(4)	A(2)	R	VC(6)		VC(5)
Closterium	R	R	C(9)	R	R	R	C(8)
Coelastrum	R		R		R	C(13)	R
Cosmarium		C(10)	VC(6)	C(10)	VC(7)	C(12)	VC(6)
Gloeocystis				R			R
Gongrosira				C(11)			
Mougeotia						A(3)	R
Oedogonium	C(9)	A(1)	C(5)			R	A(3)
Pediastrum	R	R	C(8)	R	C(11)	C(11)	C(7)
Scenedesmus	C(12)	C(11)	VC(7)	A(6)	VC(8)	VC(10)	R
Sphaerocystis		R					
Spirogyra						VC(7)	
Stigeoclonium	C(10)	A(5)	VC(4)	A(3)	A(4)	C(9)	C(9)
Tetraspora							R
Ulothrix	R			C(9)	R	R	
Chrysophyta (yellow-green algae)							
Tribonema	R		R				
Vaucheria	R						
Cyanophyta (blue-green algae)							
Calothrix		C(12)	C(12)	R	R	R	
Chamaesiphon	A(8)	A(9)			C(12)		C(13)
Dichothrix	C(11)	R				A(2)	R
Gloeotrichia	R						
Nostoc	VA(1)	VA(2)	C(10)	VC(5)	VA(3)		VA(1)
Oscillatoria	VA(2)	VC(7)		VA(2)	VA(1)	VA(1)	C(10)
Phormidium	VA(5)	VC(6)	VA(3)	VA(4)	VA(5)		VA(4)
Rivularia	A(7)				R	A(6)	
Tolypothrix		R					R
Phaeophyta (brown algae)							
Heribaudiella				R	C(9)	R	
Rhodophyta (red algae)							
Audouinella	VC(6)	R	R		R		
Lemanea						C(8)	
Higher Aquatic Plants							
mosses		x	x				x
STATION NUMBER:	**11.5**	**11.7**	**12**	**12.5**	**13**	**14**	**15.5**
TOTAL NON-DIATOM GENERA:	19	18	15	16	18	19	19
# DOMINANT GENERA:	12	11	12	10	11	13	12
# GREEN:	5	6	8	7	6	9	7
# BLUE-GREEN:	6	5	3	3	4	3	4
# OTHER:	1	0	1	0	1	1	1
DOMINANT PHYLUM:	Cyan	Chlor	Chlor	Chlor	Chlor/Cyan	Chlor	Chlor

Appendix A (continued)

Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, 2000.

R=rare; C=common; VC=very common; A=abundant; VA=very abundant

STREAM:	**CFR**	**BRR**	**CFR**	**CFR**	**CFR**	**CFR**
STATION NUMBER:	**18**	**19**	**20**	**24**	**25**	**27**
SAMPLE NUMBER:	0676V	0278Y	0272Z	0901Q	0903Q	0905U
2000 SAMPLING DATE:	8/14	8/14	8/15	8/15	8/15	8/15
Bacillariophyta (diatoms)						
All genera collectively	VA(1)	VA(1)	VA(1)	VC(7)	VA(1)	VA(1)
Chlorophyta (green algae)						
Ankistrodesmus	VC(9)	A(5)	VC(13)	A(8)	VC(9)	VC(7)
Bulbochaete						C(8)
Chaetophora						VC(5)
Cladophora	VC(3)	C(4)	VC(4)	VC(1)	A(2)	VC(2)
Closterium	C(7)	C(12)	VC(8)	C(11)	C(10)	R
Coelastrum	C(10)	VC(10)	VC(10)	VC(10)	C(12)	C(14)
Cosmarium	VC(6)	C(11)	VC(9)	VC(9)	VC(7)	VC(3)
Gloeocystis		C(13)				R
Gongrosira			R			
Mougeotia						C(11)
Oedogonium	R		R			R
Pediastrum	C(8)	VC(6)	VC(6)	C(12)	R	C(13)
Scenedesmus	VC(5)	A(3)	A(5)	A(4)	A(5)	A(6)
Spirogyra		R				VC(4)
Staurastrum	R	VC(7)	VC(7)			
Stigeoclonium	VC(4)	R	A(2)		VC(8)	R
Ulothrix		R	R			
Cyanophyta (blue-green algae)						
Calothrix					C(11)	C(10)
Chamaesiphon				VA(3)	A(6)	
Dichothrix						C(12)
Merismopedia						R
Oscillatoria	R	VC(8)	R	A(2)		R
Phormidium	VA(2)	A(9)	VA(3)	A(6)	VA(4)	R
Phaeophyta (brown algae)						
Heribaudiella		A(2)	C(12)			C(9)
Rhodophyta (red algae)						
Asterocystis			C(11)	VC(5)	A(3)	R
Audouinella	R	R				

STATION NUMBER:	**18**	**19**	**20**	**24**	**25**	**27**
TOTAL NON-DIATOM GENERA:	13	16	16	11	12	21
# DOMINANT GENERA:	9	12	12	11	11	13
# GREEN:	8	9	9	7	7	10
# BLUE-GREEN:	1	2	1	3	3	2
# OTHER:	O	1	2	1	1	1
DOMINANT PHYLUM:	Chlor	Chlor	Chlor	Chlor	Chlor	Chlor

APPENDIX B
2000 Diatom algae
Taxa, proportional counts and metrics

Appendix B

Diatom proportional count data, Clark Fork Basin biological monitoring, August 14-19, 2000.
PT = Pollution Tolerance class number; PRA = Percent Relative Abundance. A letter "p" denotes species encountered during floristic scan, but not during count.

		BTC	SBC	SBC	SBC	MWB	SBC	WSC
STATION NUMBER:		**SF-1**	**00**	**01**	**2.5**	**MW-2**	**4.5**	**06**
SAMPLE NUMBER:		1398H	0847O	0102U	0245J	1019I	1399H	1020O
2000 SAMPLING DATE:		8/19	8/19	8/18	8/18	8/18	8/18	8/18
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Achnanthes biasolettiana	3							p
Achnanthes exigua	3	p						
Achnanthes laevis	3							p
Achnanthes lanceolata	2	14.63	1.80	0.96	p	1.67	0.36	0.12
Achnanthes marginulata	3							p
Achnanthes minutissima	3	4.88	0.84	0.48	9.48	5.26	0.96	6.80
Amphora libyca	3	p		p				
Amphora pediculus	3	p						0.49
Amphora veneta	1	p	0.72	p			0.36	
Caloneis bacillum	2							0.12
Cocconeis pediculus	3	p				15.79	1.80	0.36
Cocconeis placentula	3	1.19	0.24	p		7.66	4.91	2.43
Cyclostephanos invisitatus	2	0.59						
Cyclotella meneghiniana	2	3.33	26.74	0.48		11.12	3.11	1.09
Cymatopleura solea	2					p		
Cymbella affinis	3					0.36	0.96	5.22
Cymbella amphicephala	3							p
Cymbella caespitosa	2							p
Cymbella cistula	3						p	
Cymbella cuspidata	3	p						
Cymbella microcephala	2					0.48		
Cymbella minuta	2	0.12						
Cymbella prostrata	3							p
Cymbella reichardtii	3							p
Cymbella silesiaca	3	6.78	21.94	0.48	0.24	1.08	0.24	10.33
Cymbella sinuata	3	p			0.60	0.84	p	0.85
Cymbella turgidula	3					0.12	p	2.19
Diatoma hyemalis	3				p			
Diatoma mesodon	3	p						p
Diatoma vulgaris	3	1.90				0.48	1.68	3.16
Epithemia adnata	2							p
Epithemia sorex	3					2.27	14.25	
Fragilaria bicapitata	2		0.24					
Fragilaria brevistriata	3		0.24			p		0.36
Fragilaria capucina	2	0.71	3.84	1.20	1.32	0.12	0.24	1.09
Fragilaria construens	3	16.17	6.47	0.60	p	4.78	0.48	7.05
Fragilaria crotonensis	3		p					
Fragilaria leptostauron	3					0.84	0.12	1.46
Fragilaria nitzschioides	3			p				
Fragilaria parasitica	2	p						
Fragilaria pinnata	3					2.27		1.70
Fragilaria vaucheriae	2	2.85	3.00	0.24	2.64	0.48	0.24	0.24
Frustulia vulgaris	2	p						
Gomphoneis eriense	3						p	
Gomphoneis minuta	3	p						p
Gomphonema aquaemineralis	3	p			p			
Gomphonema clavatum	2						1.68	
Gomphonema gracile	2					0.24		
Gomphonema micropus	2							0.61

Appendix B (continued)

STREAM:		BTC	SBC	SBC	SBC	MWB	SBC	WSC
STATION NUMBER:		**SF-1**	**00**	**01**	**2.5**	**MW-2**	**4.5**	**06**
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Gomphonema minusculum	3					0.36		
Gomphonema minutum	3	2.26				18.66	5.15	0.24
Gomphonema olivaceum	3				p	2.51	0.24	p
Gomphonema parvulum	1	0.71	1.92	18.75	3.36	9.21	6.83	p
Gomphonema truncatum	3	p				0.96	0.72	0.24
Melosira varians	2	3.57	0.12			0.48		1.94
Meridion circulare	3	p						
Navicula atomus	1		p	0.48	7.68			
Navicula capitata	2	0.36						
Navicula capitatoradiata	2	1.19					p	2.79
Navicula clementis	2	p						
Navicula cryptocephala	3	0.71	p					0.36
Navicula cryptotenella	2	0.36				0.72	9.82	6.80
Navicula decussis	3	0.83						0.24
Navicula gregaria	2	0.71		0.24				p
Navicula ignota	2	p				p		
Navicula laevissima	3			p				p
Navicula lanceolata	2	0.12				p		
Navicula libonensis	2							0.24
Navicula menisculus	2	0.48						0.36
Navicula minima	1	3.33	3.00	13.70	46.70	0.12	0.24	0.73
Navicula minuscula	1	1.78	0.48	0.48	2.04			
Navicula molestiformis	1	p	0.36		0.24			
Navicula oligotraphenta	3	0.12		p				p
Navicula protracta	2	p	p			0.24		
Navicula pupula	2	0.12	p	p			p	0.49
Navicula reichardtiana	2	0.24				0.36	p	2.92
Navicula seminulum	1			1.80	p			
Navicula tripunctata	3	1.07				p	2.87	8.02
Navicula trivialis	2	0.12						
Navicula veneta	1		0.24	p	p	p		
Navicula wiesneri	1	0.59			p			
Neidium binodeformis	2	p						
Nitzschia acicularis	2	0.24	0.24					p
Nitzschia alpina	3	1.31						
Nitzschia amphibia	2	1.90					0.24	0.49
Nitzschia archibaldii	2	p				p		2.31
Nitzschia bacillum	3	p						
Nitzschia communis	1		p		0.60			
Nitzschia commutatoides	2				p			
Nitzschia dissipata	3	8.56				p	1.44	11.54
Nitzschia draveillensis	1							p
Nitzschia fonticola	3	4.99	0.48				16.65	
Nitzschia hantzschiana	3	1.43	2.88				0.84	0.36
Nitzschia heufleriana	3	p						
Nitzschia inconspicua	2	4.04	0.72		p	0.24	0.12	0.24
Nitzschia lacuum	3							0.73
Nitzschia linearis	2	0.12	0.24	0.12		p	p	p
Nitzschia microcephala	1							p
Nitzschia palea	1	0.71	14.39	42.07	21.61	0.12	0.36	1.94
Nitzschia paleacea	2	1.43	0.24	0.12		0.84	16.53	1.22
Nitzschia perminuta	3						p	
Nitzschia pusilla	1	1.19		p				0.73
Nitzschia radicula	2						p	
Nitzschia recta	3	p						0.36

Appendix B (continued)

STREAM:		BTC	SBC	SBC	SBC	MWB	SBC	WSC
STATION NUMBER:		SF-1	00	01	2.5	MW-2	4.5	06
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Nitzschia sigmoidea	3	p						p
Nitzschia sociabilis	1							p
Nitzschia supralitorea	2	p	p			p		
Nitzschia umbonata	1			p	p			
Nitzschia vermicularis	2							p
Opephora olsenii	3	p	p			0.24	0.24	
Pinnularia obscura	2				p			
Rhoicosphenia abbreviata	3	0.12			p	5.98	3.11	p
Rhopalodia gibba	2						0.24	
Stauroneis smithii	2							p
Stephanodiscus hantzschii	2	0.71						
Stephanodiscus minutulus	2			p				
Surirella angusta	1	p		0.12	0.24			
Surirella brebissonii	2		0.72		1.92			
Surirella minuta	2		p	0.60	0.96	0.36	p	
Synedra ulna	2	p	7.91	17.07	0.36	0.84	2.99	8.02
Thalassiosira pseudonana	2	0.95						

STREAM:	BTC	SBC	SBC	SBC	MWB	SBC	WSC
STATION NUMBER:	SF-1	00	01	2.5	MW-2	4.5	06
METRIC							
Valves Counted:	841	834	832	833	836	835	823
Total Species:	73	35	30	29	46	45	68
Species Counted:	45	26	19	16	36	33	44
Shannon Diversity:	4.43	3.25	2.40	2.45	3.90	3.84	4.52
Pollution Index:	2.44	2.12	1.24	1.28	2.63	2.49	2.62
Siltation Index:	38.05	23.98	59.74	81.99	2.99	49.10	42.89
Disturbance Index:	4.88	0.84	0.48	9.48	5.26	0.96	6.80
Percent Epithemiaceae:					2.27	14.25	
Total PRA PT Class 1:	8.32	21.10	77.40	82.47	9.45	7.78	3.40
Total PRA PT Class 2:	38.88	45.80	21.03	7.20	18.18	35.57	31.11
Total PRA PT Class 3:	52.79	33.09	1.56	10.32	72.37	56.65	65.49

Appendix B

Diatom proportional count data, Clark Fork Basin biological monitoring, August 14-19, 2000.
PT = Pollution Tolerance class number; PRA = Percent Relative Abundance. A letter "p" denotes species encountered during floristic scan, but not during count.

STREAM:		CFR	CFR	CFR	CFR	CFR	LBR	CFR
STATION NUMBER:		**07**	**08**	**8.5**	**09**	**10**	**10.2**	**11**
SAMPLE NUMBER:		0849R	1021J	1049F	0266Y	0850Q	1400H	0556Q
2000 SAMPLING DATE:		8/18	8/17	8/17	8/17	8/17	8/17	8/17
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Achnanthes biasolettiana	3		p		p			
Achnanthes exigua	3		p					
Achnanthes laevis	3			p				
Achnanthes lanceolata	2	1.21	1.55	p	p	0.24	1.54	0.96
Achnanthes marginulata	3	p						
Achnanthes minutissima	3	3.26	1.43	26.76	17.64	3.73	2.13	0.60
Amphipleura pellucida	2			p				
Amphora inariensis	3	p						p
Amphora libyca	3	p		p				
Amphora pediculus	3	0.60	0.96	p	0.36	2.17	0.71	1.67
Amphora veneta	1	0.12		p		p		
Caloneis silicua	2		p					
Cocconeis pediculus	3	1.09	p	p		0.12	4.38	2.63
Cocconeis placentula	3	3.14	7.53	0.48	0.36	5.30	17.06	4.78
Cyclotella meneghiniana	2	1.45	1.91	1.45	p	0.48	11.73	0.60
Cymatopleura elliptica	2		p					
Cymatopleura solea	2		0.24		p			
Cymbella affinis	3	3.02	0.12	5.21	0.97	0.24	2.13	p
Cymbella caespitosa	2						p	
Cymbella cistula	3			0.36	p			
Cymbella descripta	3			p				
Cymbella mexicana	3	p	p	p				
Cymbella microcephala	2		0.48	5.93	4.38			
Cymbella naviculiformis	3		p					
Cymbella reichardtii	3	0.36				p		
Cymbella silesiaca	3	5.07	2.39	1.82	2.07	4.34	1.54	1.91
Cymbella sinuata	3	1.09	0.96	p		1.45	p	0.96
Cymbella turgidula	3	0.60		0.97	p	p	1.18	p
Denticula kuetzingii	3				0.24			
Diatoma mesodon	3	p						
Diatoma moniliformis	2		0.12	0.73	0.24	0.24	0.12	
Diatoma tenuis	2		p			p		
Diatoma vulgaris	3	0.85	1.19	2.30	5.60	0.72	p	0.72
Epithemia adnata	2				p			0.24
Epithemia sorex	3	10.87	17.92	0.48		25.06	10.43	44.92
Epithemia turgida	3					p		
Fragilaria brevistriata	3	0.60	0.24	p	0.49	1.20		
Fragilaria capucina	2	0.72	0.48	3.15	0.12		0.24	0.12
Fragilaria construens	3	2.17	3.46	2.42	1.95	3.61	14.22	3.35
Fragilaria leptostauron	3	1.69	0.96	0.24	0.49	0.72	1.30	0.48
Fragilaria nanana	3			p	p			
Fragilaria parasitica	2		0.72		p	p		
Fragilaria pinnata	3	0.24	1.31	p		0.12	0.71	0.12
Fragilaria vaucheriae	2	0.48	0.12			2.29	0.24	p
Gomphoneis eriense	3	p					p	
Gomphonema aquaemineralis	3	p				0.36		
Gomphonema clavatum	2	1.09	p	p		0.24	0.24	p
Gomphonema gracile	2			p		p		
Gomphonema micropus	2	p						

Appendix B (continued)

STREAM:		CFR	CFR	CFR	CFR	CFR	LBR	CFR
STATION NUMBER:		07	08	8.5	09	10	10.2	11
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Gomphonema minusculum	3	p						
Gomphonema minutum	3	3.14					1.18	p
Gomphonema olivaceum	3	0.36	1.08	0.48	0.36	0.60	0.24	p
Gomphonema parvulum	1	1.09	0.96	0.73	0.24	0.84	p	0.36
Gomphonema pumilum	3	1.45				0.24	1.54	p
Gomphonema truncatum	3			1.21	0.24		p	
Melosira varians	2	0.97	2.63	p	p		p	p
Navicula bryophila	3					p		
Navicula capitata	2							p
Navicula capitatoradiata	2	3.50	0.36		0.24	0.12	1.30	0.72
Navicula cryptocephala	3	0.12		p			p	
Navicula cryptotenella	2	9.18	3.70	5.33	8.64	18.55	0.83	15.29
Navicula decussis	3	0.24	1.08	p	0.12	1.45		0.96
Navicula gregaria	2	p						
Navicula ignota	2	p	0.24	p		p	p	p
Navicula lanceolata	2	p		p		p		p
Navicula libonensis	2	p	p					
Navicula menisculus	2	0.24	0.24				0.24	0.24
Navicula minima	1	0.24	p		p	0.72	0.47	0.24
Navicula oligotraphenta	3	p	p					
Navicula paramutica	2		p					
Navicula pupula	2	0.24	1.43	0.48	0.85	1.20		0.24
Navicula pygmaea	2	p						
Navicula radiosa	3			p				
Navicula reichardtiana	2	4.35	1.43	0.36		1.57	1.90	1.08
Navicula tripunctata	3	4.35	0.36	0.12	0.24	p	2.13	4.42
Neidium dubium	3		p			p		
Nitzschia acicularis	2		0.48	1.45	0.73	p	p	
Nitzschia acidoclinata	3							0.24
Nitzschia amphibia	2	0.48	0.48		p	p	0.24	
Nitzschia archibaldii	2		2.75	1.21	p		2.61	
Nitzschia bacillum	3	0.12						
Nitzschia calida	2		p					
Nitzschia capitellata	2		p	0.48		0.48		
Nitzschia communis	1	p	0.60			p		
Nitzschia denticula	3			0.24				
Nitzschia dissipata	3	5.31	8.12	4.12	1.34	2.53	p	2.51
Nitzschia draveillensis	1			p				
Nitzschia flexoides	2				0.24			
Nitzschia fonticola	3	5.43	5.26	0.61		1.20	12.56	1.31
Nitzschia graciliformis	2	p						
Nitzschia hantzschiana	3	0.12	1.08	p	p		0.36	0.48
Nitzschia heufleriana	3	0.12		0.24	0.24	0.24	p	
Nitzschia hungarica	2	p		p	p			
Nitzschia inconspicua	2	1.21	0.36	p	0.24	4.94	1.90	1.19
Nitzschia linearis	2	0.60	1.67	1.09	1.58	1.08		0.12
Nitzschia littorea	2		p					
Nitzschia palea	1	2.90	8.96	9.08	5.72	3.01	1.18	0.96
Nitzschia paleacea	2	1.81	2.75	0.85	0.24	1.45	0.47	3.35
Nitzschia perminuta	3	p				p		
Nitzschia pumila	2		p				p	
Nitzschia pura	2		p					
Nitzschia pusilla	1		p					
Nitzschia recta	3	0.24	0.12	0.12	p	p		
Nitzschia sigmoidea	3	p			p			

Appendix B (continued)

STREAM:		CFR	CFR	CFR	CFR	CFR	LBR	CFR
STATION NUMBER:		**07**	**08**	**8.5**	**09**	**10**	**10.2**	**11**
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Nitzschia sociabilis	1	1.69	0.96	p	0.12	1.08		
Nitzschia supralitorea	2	0.48	0.36		p	p	p	
Nitzschia vermicularis	2		p	p				
Opephora olsenii	3		0.24		0.24	0.24		0.24
Pinnularia appendiculata	3	p	0.12					
Pinnularia microstauron	2						p	p
Pinnularia subrostrata	2			p				
Rhoicosphenia abbreviata	3	3.26	2.51	0.48	0.49	3.61	0.71	2.03
Rhopalodia gibba	2	0.48	0.60			p		
Stauroneis smithii	2	p	p	p				
Surirella brebissonii	2		p		p			
Surirella minuta	2	0.12	p	p		p		
Synedra ulna	2	6.40	5.02	19.01	42.94	2.17	0.24	p

STREAM:	CFR	CFR	CFR	CFR	CFR	LBR	CFR
STATION NUMBER:	**07**	**08**	**8.5**	**09**	**10**	**10.2**	**11**
METRIC							
Valves Counted:	828	837	826	822	830	844	837
Total Species:	74	74	64	52	60	50	48
Species Counted:	52	50	34	33	40	35	34
Shannon Diversity:	4.88	4.62	3.72	2.99	4.03	3.96	3.20
Pollution Index:	2.53	2.47	2.39	2.27	2.54	2.73	2.73
Siltation Index:	43.12	42.77	25.79	20.56	39.64	26.18	33.33
Disturbance Index:	3.26	1.43	26.76	17.64	3.73	2.13	0.60
Percent Epithemiaceae:	10.87	17.92	0.48		25.06	10.43	45.16
Total PRA PT Class 1:	6.04	11.47	9.81	6.08	5.66	1.66	1.55
Total PRA PT Class 2:	35.02	30.11	41.53	60.46	35.06	23.82	24.13
Total PRA PT Class 3:	58.94	58.42	48.67	33.45	59.28	74.53	74.31

Appendix B
Diatom proportional count data, Clark Fork Basin biological monitoring, August 14-19, 2000.
PT = Pollution Tolerance class number; PRA = Percent Relative Abundance. A letter "p" denotes species encountered during floristic scan, but not during count.

STREAM:		**FTC**	**CFR**	**CFR**	**RKC**	**CFR**	**BFR**	**CFR**
STATION NUMBER:		**11.5**	**11.7**	**12**	**12.5**	**13**	**14**	**15.5**
SAMPLE NUMBER:		1401H	0652I	0557Q	1402H	0558W	0752U	0897R
2000 SAMPLING DATE:		8/16	8/16	8/16	8/16	8/16	8/15	8/14
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Achnanthes biasolettiana	3					p	2.88	0.96
Achnanthes clevei	3		p		p		0.24	
Achnanthes daui	3							p
Achnanthes lanceolata	2	1.54	0.72	0.59	0.72	0.24	0.36	0.12
Achnanthes marginulata	3				p			
Achnanthes minutissima	3	1.42	0.24	0.24	6.24	2.31	18.49	15.71
Achnanthes suchlandtii	3							p
Amphipleura pellucida	2						0.48	0.60
Amphora inariensis	3			p				
Amphora libyca	3		p	p				p
Amphora montana	2						p	
Amphora pediculus	3	1.18	0.36	1.18	0.24	0.97	1.32	0.48
Caloneis alpestris	3	p						
Caloneis silicua	2			0.24				
Cocconeis pediculus	3	0.47	1.20	1.53	0.24	0.36	0.24	1.92
Cocconeis placentula	3	2.73	1.08	1.30	7.32	1.46	2.16	2.28
Cyclotella meneghiniana	2	7.58	p	0.47	0.36	1.22	p	0.72
Cymatopleura solea	2							p
Cymbella affinis	3	9.36	p	0.12	p	3.40	23.53	7.07
Cymbella aspera	3						p	
Cymbella caespitosa	2				0.96	p	0.72	0.12
Cymbella mesiana	3	p						0.24
Cymbella mexicana	3			p	0.12	p		
Cymbella microcephala	2				p		7.20	0.84
Cymbella minuta	2	0.59			5.52	1.22	0.72	0.48
Cymbella muelleri	2				p		p	p
Cymbella prostrata	3						0.12	p
Cymbella silesiaca	3	0.36	0.48	0.24	6.48	5.22	3.72	2.40
Cymbella sinuata	3	0.83	0.72	0.47	0.48	1.58	0.48	0.36
Cymbella turgidula	3	4.62		p	p	4.62	7.08	2.28
Diatoma mesodon	3				p			p
Diatoma moniliformis	2					12.03		2.52
Diatoma tenuis	2							p
Diatoma vulgaris	3	0.24	13.34	14.76	0.72	1.09		1.56
Epithemia adnata	2						0.24	
Epithemia sorex	3	8.89	23.44	37.54	8.28	6.56	0.72	3.36
Epithemia turgida	3				1.80	0.12	p	p
Fragilaria brevistriata	3							p
Fragilaria capucina	2				p	p	3.24	p
Fragilaria construens	3	2.01	3.49	0.94	5.88	2.19	1.44	4.44
Fragilaria leptostauron	3	0.24	0.12	p	2.40	0.73	0.72	p
Fragilaria mazamaensis	3				0.60	p	p	p
Fragilaria parasitica	2		0.24	p				
Fragilaria pinnata	3	0.71	0.24	1.42	2.28	0.85	0.36	0.72
Fragilaria vaucheriae	2	0.24	p	p	0.24	p	0.24	1.20
Gomphoneis eriense	3	p		0.12	0.24		0.12	p
Gomphoneis minuta	3				p		0.24	
Gomphonema acuminatum	3	p						
Gomphonema aquaemineralis	3	p						

Appendix B (continued)

STREAM:		FTC	CFR	CFR	RKC	CFR	BFR	CFR
STATION NUMBER:		**11.5**	**11.7**	**12**	**12.5**	**13**	**14**	**15.5**
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Gomphonema micropumilum	3				p			p
Gomphonema micropus	2					p		
Gomphonema minusculum	3						1.44	
Gomphonema minutum	3	3.20	0.60	0.12	0.12	0.97	0.72	1.68
Gomphonema olivaceum	3	0.36	1.80	0.59		0.97	0.36	0.36
Gomphonema parvulum	1	0.83	0.24	0.59		0.24	0.48	p
Gomphonema procerum	3						p	p
Gomphonema pseudotenellum	3						p	
Gomphonema pumilum	3	2.61			1.32		2.28	1.44
Gomphonema rhombicum	3	0.24			3.48			
Gomphonema truncatum	3	p	0.24			p	p	
Hannaea arcus	3							0.12
Melosira varians	2		p					p
Meridion circulare	3		p					p
Navicula bacillum	3						p	p
Navicula bryophila	3							0.24
Navicula capitata	2					p		
Navicula capitatoradiata	2	5.09	4.09	2.72	3.00	3.77	1.68	6.59
Navicula cryptotenella	2	7.70	7.33	9.80	0.36	8.02	1.20	4.32
Navicula cuspidata	2			p				
Navicula decussis	3		0.12	0.12		p		p
Navicula ignota	2	0.47		0.12		p		
Navicula lanceolata	2	p				p		0.12
Navicula menisculus	2	0.24	p	p	0.24	p	0.24	p
Navicula minima	1	0.95		0.35		p		
Navicula oligotraphenta	3					p		
Navicula pupula	2	0.24	0.24	0.24		p	p	p
Navicula radiosa	3				0.24	0.12	p	p
Navicula radiosafallax	2							0.12
Navicula reichardtiana	2	1.18	0.84	0.71	1.80	p	0.96	1.80
Navicula subhamulata	2						p	
Navicula tripunctata	3	2.84	4.57	2.36	0.24	0.36	0.24	0.60
Navicula trivialis	2	p						
Neidium dubium	3	p						
Nitzschia acicularis	2			p	p	0.49	p	p
Nitzschia acidoclinata	3	p						
Nitzschia agnita	1	p						
Nitzschia alpina	3						p	
Nitzschia amphibia	2				p			
Nitzschia angustata	2						p	
Nitzschia archibaldii	2	0.95	p	p	p	p	p	3.60
Nitzschia capitellata	2	p		p		p		
Nitzschia dissipata	3	0.83	4.33	2.95	0.24	0.73	1.32	6.47
Nitzschia draveillensis	1						0.72	0.24
Nitzschia fonticola	3	2.37	2.28	2.48	16.69	9.72	p	5.40
Nitzschia graciliformis	2							0.24
Nitzschia hantzschiana	3	3.67			1.20	p	0.48	1.44
Nitzschia heufleriana	3	p	0.24	p		p		p
Nitzschia hungarica	2	p						
Nitzschia inconspicua	2	3.32	0.24	0.24	1.56	0.97		0.48
Nitzschia lacuum	3					p	0.24	p
Nitzschia linearis	2	0.24	0.24	0.12				
Nitzschia palea	1	4.15	p	2.13	0.24	4.13	0.48	4.56
Nitzschia paleacea	2	6.64	0.96	2.83	14.29	17.74	0.48	4.08
Nitzschia perminuta	3				0.24			

Appendix B (continued)

		STREAM:	**FTC**	**CFR**	**CFR**	**RKC**	**CFR**	**BFR**	**CFR**
		STATION NUMBER:	**11.5**	**11.7**	**12**	**12.5**	**13**	**14**	**15.5**
SPECIES		PT	PRA	PRA	PRA	PRA	PRA	PRA	PRA
Nitzschia pumila		2	0.71						
Nitzschia pura		2	p						
Nitzschia pusilla		1	p						
Nitzschia radicula		2						p	p
Nitzschia recta		3	0.59						0.24
Nitzschia sigmoidea		3		p					
Nitzschia sociabilis		1		p					
Nitzschia subaciculanis		2				p		p	
Nitzschia supralitorea		2	0.36	0.24					
Opephora olsenii		3	p	0.24		0.48	0.24		p
Rhoicosphenia abbreviata		3	6.99	5.89	2.24	1.32	0.85		0.60
Rhopalodia gibba		2	p	p				0.24	p
Stauroneis kriegerii		3				p			
Stauroneis smithii		2		p					p
Stephanodiscus minutulus		2	p						
Surirella angusta		1	p						
Surirella brebissonii		2	p						
Surirella minuta		2	0.24				p		0.24
Synedra ulna		2		19.59	8.15	1.80	4.50	9.36	4.68

	STREAM:	**FTC**	**CFR**	**CFR**	**RKC**	**CFR**	**BFR**	**CFR**
	STATION NUMBER:	**11.5**	**11.7**	**12**	**12.5**	**13**	**14**	**15.5**
METRIC								
Valves Counted:		844	832	847	833	823	833	834
Total Species:		64	47	47	54	57	63	77
Species Counted:		43	33	34	39	34	43	46
Shannon Diversity:		4.65	3.58	3.35	4.18	4.17	3.95	4.64
Pollution Index:		2.51	2.65	2.68	2.69	2.41	2.69	2.58
Siltation Index:		42.77	25.72	27.15	40.34	46.05	8.04	40.77
Disturbance Index:		1.42	0.24	0.24	6.24	2.31	18.49	15.71
Percent Epithemiaceae:		8.89	23.44	37.54	10.08	6.68	0.96	3.357
Total PRA PT Class 1:		5.92	0.24	3.07	0.24	4.37	1.68	4.80
Total PRA PT Class 2:		37.32	34.74	26.21	30.85	50.18	27.37	32.85
Total PRA PT Class 3:		56.75	65.02	70.72	68.91	45.44	70.95	62.35

Appendix B
Diatom proportional count data, Clark Fork Basin biological monitoring, August 14-19, 2000.
PT = Pollution Tolerance class number; PRA = Percent Relative Abundance. A letter "p" denotes species encountered during floristic scan, but not during count.

STREAM:		CFR	BRR	CFR	CFR	CFR	CFR
STATION NUMBER:		**18**	**19**	**20**	**24**	**25**	**27**
SAMPLE NUMBER:		0676V	0278Y	0272Z	0901Q	0903Q	0905U
2000 SAMPLING DATE:		8/14	8/14	8/15	8/15	8/15	8/15
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA
Achnanthes biasolettiana	3	0.24	6.34	1.58	0.12	p	11.71
Achnanthes bioretii	3				p		p
Achnanthes clevei	3			p			p
Achnanthes exigua	3				p		
Achnanthes laevis	3				p		p
Achnanthes lanceolata	2	p	0.24	0.36	p	0.61	p
Achnanthes laterostrata	3		p				
Achnanthes minutissima	3	3.54	26.44	8.75	6.86	7.80	15.61
Achnanthes ziegleri	3						p
Amphipleura pellucida	2				0.24	0.12	p
Amphora libyca	3						p
Amphora pediculus	3	0.59	p	0.73	1.66	0.24	0.49
Anomoeoneis styriaca	2						p
Anomoeoneis vitrea	2						3.90
Caloneis bacillum	2		p		0.24		
Caloneis tenuis	3					p	
Cocconeis neodiminuta	3						0.24
Cocconeis pediculus	3	1.30	0.36	0.97	10.77	5.12	0.24
Cocconeis placentula	3	2.71	5.38	1.70	13.73	11.69	1.59
Cyclostephanos invisitatus	2						p
Cyclotella bodanica	2						p
Cyclotella comensis	3						0.24
Cyclotella meneghiniana	2	0.24	p	1.22	2.60	2.56	0.73
Cyclotella ocellata	3						p
Cyclotella pseudostelligera	2						p
Cymbella affinis	3	20.52	14.00	22.24	12.66	11.33	10.37
Cymbella caespitosa	2	0.24		p	p	0.24	0.24
Cymbella cistula	3						p
Cymbella cymbiformis	3		6.70	p			
Cymbella delicatula	3						1.34
Cymbella descripta	3						p
Cymbella mexicana	3	p				p	
Cymbella microcephala	2	0.24		p	p		19.39
Cymbella minuta	2	0.47	2.51	1.70	1.30	1.46	p
Cymbella prostrata	3	p				p	p
Cymbella silesiaca	3	1.06	2.87	1.46	1.54	2.56	p
Cymbella sinuata	3	1.65	0.72	1.09	2.49	3.41	0.61
Cymbella turgidula	3	8.49	4.67	3.89	4.14	1.10	1.22
Diatoma moniliformis	2	0.71		p	0.47	0.85	
Diatoma tenuis	2						p
Diatoma vulgaris	3	0.94	0.36	1.46	0.47	1.46	p
Epithemia adnata	2					p	p
Epithemia sorex	3	1.30		0.97	1.66	7.80	p
Epithemia turgida	3		0.24		p	0.73	
Fragilaria capucina	2		0.84			0.73	6.59
Fragilaria construens	3	1.30	p	0.36	2.60	2.44	2.80
Fragilaria leptostauron	3	p	p	p	1.07	1.34	0.24
Fragilaria mazamaensis	3				p		
Fragilaria nanana	3			p		p	0.73

Appendix B (continued)

STREAM:		CFR	BRR	CFR	CFR	CFR	CFR
STATION NUMBER:		18	19	20	24	25	27
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA
Fragilaria pinnata	3	0.71	p	p	0.12	0.61	p
Fragilaria tenera	2						2.44
Fragilaria vaucheriae	2	p	p		0.24	p	
Gomphoneis eriense	3	p	0.48	0.24	p	p	
Gomphoneis minuta	3	p	p	p		p	
Gomphonema aquaemineralis	3	0.12					
Gomphonema clavatum	2	p		0.24		p	
Gomphonema micropumilum	3	p	1.67				
Gomphonema minusculum	3			p	p	0.61	0.24
Gomphonema minutum	3	3.18	0.72	2.31	5.80	3.53	0.24
Gomphonema olivaceum	3	p		p	0.12		0.37
Gomphonema parvulum	1	0.94	0.96	p	0.24		
Gomphonema procerum	3		p	p	0.24		p
Gomphonema pumilum	3	0.94	4.31	1.09	3.79	2.31	
Gomphonema rhombicum	3	p	p			p	
Gomphonema truncatum	3	p	p	p			
Hannaea arcus	3					p	
Melosira varians	2	0.94	p				
Navicula capitata	2			p			
Navicula capitatoradiata	2	12.26	1.44	15.07	5.80	6.82	0.49
Navicula cryptocephala	3		p	p			
Navicula cryptotenella	2	8.73	0.36	7.90	6.04	2.44	2.93
Navicula decussis	3		p	p	0.24	p	
Navicula elginensis	3					p	
Navicula ignota	2	p	p	0.12	0.24	p	
Navicula menisculus	2	p	p	p	p	p	p
Navicula minima	1		p				
Navicula molestiformis	1	p		p			
Navicula perminuta	2		0.48				
Navicula pupula	2	p			p	p	p
Navicula radiosa	3				p		
Navicula reichardtiana	2	0.24	p	0.97	0.24	0.24	p
Navicula stroemii	2						p
Navicula tripunctata	3	2.71	0.24	4.74	0.83	1.71	0.12
Navicula trivialis	2	p					
Navicula veneta	1	p					
Navicula wildii	2		0.24				
Nitzschia acicularis	2	p			0.24	0.73	
Nitzschia amphibia	2	1.30		0.24			
Nitzschia archibaldii	2	1.18	1.67	0.61		0.49	
Nitzschia dissipata	3	3.07	0.24	1.58	0.47	0.49	0.61
Nitzschia draveillensis	1						p
Nitzschia flexoides	2					p	
Nitzschia fonticola	3	8.14	1.08	5.59	2.01	4.99	1.22
Nitzschia graciliformis	2	0.47			p		
Nitzschia hantzschiana	3	0.24		0.12	0.47	0.12	
Nitzschia heufleriana	3	p			p		
Nitzschia inconspicua	2	0.24	0.36	0.61	p	0.85	
Nitzschia lacuum	3						p
Nitzschia linearis	2		p		p		
Nitzschia palea	1	4.01	p	1.82	0.24	0.24	
Nitzschia paleacea	2	1.89	0.24	0.49	0.24	0.97	
Nitzschia perminuta	3			p		p	
Nitzschia pumila	2				p	0.24	
Nitzschia radicula	2			0.24			

Appendix B (continued)

STREAM:		CFR	BRR	CFR	CFR	CFR	CFR
STATION NUMBER:		**18**	**19**	**20**	**24**	**25**	**27**
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA
Nitzschia subacicularis	2			p			
Nitzschia vermicularis	2				p		
Opephora olsenii	3	0.24	p		0.59	0.61	0.49
Rhoicosphenia abbreviata	3	0.24	p	0.36	0.83	0.49	p
Rhopalodia gibba	2					0.24	
Stauroneis smithii	2	p					
Synedra ulna	2	2.71	13.88	7.17	6.39	7.67	12.56
Thalassiosira pseudonana	2				p	p	

STREAM:	CFR	BRR	CFR	CFR	CFR	CFR
STATION NUMBER:	**18**	**19**	**20**	**24**	**25**	**27**
METRIC						
Valves Counted:	848	836	823	845	821	820
Total Species:	60	53	56	60	61	60
Species Counted:	39	30	35	40	41	30
Shannon Diversity:	4.18	3.62	3.97	4.25	4.48	3.65
Pollution Index:	2.58	2.76	2.59	2.75	2.72	2.51
Siltation Index:	44.46	6.34	40.10	17.04	20.34	5.37
Disturbance Index:	3.54	26.44	8.75	6.86	7.80	15.61
Percent Epithemiaceae:	1.30	0.24	0.97	1.66	8.53	
Total PRA PT Class 1:	4.95	0.96	1.82	0.47	0.24	
Total PRA PT Class 2:	31.84	22.25	36.94	24.26	27.28	49.27
Total PRA PT Class 3:	63.21	76.79	61.24	75.27	72.47	50.73